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> *Of Nature trusts the mind which builds for aye.*"—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

> *"To the solid ground*
> *Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

THURSDAY, SEPTEMBER 3, 1914.

OUR RARER BIRDS.

Field-studies of Some Rarer British Birds. By John Walpole-Bond. Pp. x+305. (London: Witherby and Co., 1914.) Price 7*s.* 6*d.* net.

THE scope of the volume before us is well indicated by its title. Mr. Bond, indeed, keeps us from first to last in the open air observng the habits of the birds and discovering the secrets of their nests. Now the author is at home n the south-east of England, now he visits well-oved haunts in Wales; or, again, he wanders further afield—to the wild coast of Ireland, to the fastnesses of the Central Highlands, or to the moors of Orkney. It is evident that Mr. Bond writes about no mere holiday excursions, but that he has been able to give much time to field ornithology, and has travelled far and wide throughout our islands in its pursuit.

The birds which have been chosen for treatment do not all in like degree deserve the title "rare." A few, indeed, are merely rather restricted n their distribution—either from natural cause or owing to human persecution. But although the needless destruction of many of our most nteresting birds comes in for just censure, there s a brighter side to the picture: the golden eagle s well protected in Scotland, our buzzard population is estimated at more than four hundred and fifty pairs; the raven and the peregrine hold their own in the remoter districts; the hobby is more numerous than is generally supposed; the decrease of the chough is not attributed to human agencies; while the gadwall is an *addition* to our native avifauna.

In these days of nature photography, very excellent in its way, it is something of a relief to find a bird-book that is able to stand on the merits of text alone. But at the same time we become more exacting as to literary form, and therein discover our author's failing. The extraordinary number of parenthetical and other interpolated clauses gives a disjointed and inconsequent effect to a style already loose. One has the impression, indeed, that a horde of new details has been added at the last moment without any attempt at recasting the sentences. This is a grave fault, for it does much to mar the reader's pleasure while constantly "side-tracking" his interest. Nevertheless, Mr. Bond has much to tell that few know, but that many will gladly learn.

SCIENCE AND THE FARMER.

(1) *A Pilgrimage of British Farming*, 1910–1912. By A. D. Hall. Reprinted by permission from the *Times*. Pp. xiii+452. (London: John Murray, 1913.) Price 5*s.* net.

(2) *Soils and Crops; With Soils Treated in Reference to Crop Production.* By Prof. T. F. Hunt and Prof. C. W. Burkett. Pp. xiii+541. (New York: Orange Judd Co.; London: Kegan Paul, Trench, Trübner and Co., 1913.) Price 7*s.* 6*d.* net.

(3) *Manures and Fertilisers.* By Prof. H. J. Wheeler. Pp. xxi+389. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 7*s.* net.

(1) "TO see himself as others see him" is nowadays very much the fate of the man who lives in the country and gets his living by agriculture. He has only to open his morning paper to find some speech or article by some prominent person setting forth the good or bad conditions under which he and his labourers live, and propounding some remedy for the evils described.

Probably more has been written about the country during the last twelve months than about the cities, and there still continues a steady outpour of material describing the state of British agriculture in general, and the conditions of life in the country in particular. It appears, therefore, that the city dweller is much interested in the subject, and apparently much of what is written appeals to him or the shrewd publisher would not publish it. The drawback of a good deal of it is, unfortunately, that the countryman rarely recognises the descriptions, and is driven to wonder how they ever came to be written.

Mr. Hall's book stands out in sharp contrast with all this; it is written by one who knows what he is talking about, and presents a very faithful picture of British agriculture and rural conditions. The tour covered practically all the good farming districts of Great Britain and Ireland, and it brings out the high specialisation which is now becoming so characteristic of British farming. Some farms indeed can only be compared with factories, so closely specialised is the work, and so intense the production. It is not too much to say that no account has yet been printed which gives so good a description of the farming of this country, and it was a very happy inspiration indeed that led Mr. Hall and his two companions, Mr. Beaven and Prof. Wood, to go round the country in a car and put on record what was seen. The last tour of the sort was conducted by Caird in 1850–51 and a comparison of the two books shows very clearly that enormous strides have been made since that date. The economic conditions have altered considerably, but the farmer has succeeded in adapting himself to them, and has developed a system which enables him to produce a great amount of material from his land at a reasonable profit to himself.

Of course, the picture is not uniformly bright; losses still go on on the farm that ought to be checked; farmers generally cannot obtain credit and are often indebted to dealers, so that they are unable to make any complaint when unsatisfactory goods are supplied, or to take advantage of the Acts of Parliament which have been passed for their benefit; there is much room for cooperation. The labourer, too, is not so well off as he might be. He is, of course, in a much better position than is commonly made out, and he can always, if he wants, move off to the Colonies and set up farming on his own account. In general, however, he is at least as well off as the labourer in the town. Again, the system of rural education is not well adapted to the needs of the rural community. Fortunately, however, in all these directions serious efforts are being made for improvement, and we can look forward with confidence to the future.

It is impossible in a short space to discuss the various facts that Mr. Hall has recorded; perhaps the most characteristic feature noted is the close association of sheep with British farming systems: the way in which crops are grown simply for sheep to eat on the land so that the soil may be fertilised and compacted without having recourse to implements. It is quite a common thing to grow one or two fodder crops to be consumed in this manner, and to follow these with corn crops. Thus the food materials purchased for sheep help to fertilise the soil and also to keep up the supply of organic matter. It is much less common to find the farmer depending entirely on artificial manures.

The tendency to specialisation in agricultural production brings into prominence the difficulties inherent in dealing with crops, soil fertility, diseases, etc.; it makes the farmer more observant and more ready to seek scientific assistance. The skilled hop grower is far more interested in the life-history of the aphis or the mildew than is the small general farmer in any account of the rust of wheat. With specialisation in agriculture therefore, comes the opportunity to the man of science; it thus tends to bring about much closer cooperation between the agricultural and scientific adviser than was possible some years ago.

(2) The second book on our list was written by Dean Hunt and Prof. Burkett and deals with the special conditions of the United States; it is an attempt to bring into one volume sufficient material for pupils between the ages of fourteen and eighteen. It deals not only with soils and manures, but also with crops, including maize oats, wheat, barley, and a variety of others, while chapters are added on the insect pests and diseases, and on the methods of improvement of crops. Both the authors have had very great experience in teaching; Dean Hunt, now of California, saw service at the State College, Pennsylvania, and elsewhere, whilst Prof. Burkett is well known as the editor of the *American Agriculturist*, and was also director of the Kansas Agricultural Experiment Station.

The arrangement is in some respects novel the first chapter deals with food required to grow plants and includes accounts of salt, sugar starch, fat, protein, besides the usual potassium salts, phosphates, and nitrogen compounds Then the student passes on to a study of the different types of soil, and the characteristics of soils and fertilisers. As is usual in American books a liberal use is made of illustrations whilst there is a good supply of practical exer cises. Altogether the book is one that the teacher may use with great advantage and in the certainty of getting much help in devising useful courses for his classes.

(3) The third book is by Prof. Wheeler who was long director of the Agricultural Experiment Station of Rhode Island, and then became chemical expert to the American Agricultural Chemical Company. His book deals exclusively with manures and fertilisers, and is therefore more specialised than the volume just referred to. A very interesting account is given of the subject, indeed, we know of no American publication that deals better with it. The author has rightly made liberal use of the admirable series of investigations conducted at Rhode Island during the term of his directorship, and in particular goes very fully into the question of liming. Some remarkable observations were begun in 1890 at Rhode Island and it was found that sulphate of ammonia was highly toxic on certain soils, even in the first season of its application. Experiments soon showed that this effect was due to the production of acid conditions in the soil, which could be corrected by sodium carbonate, potassium carbonate, calcium carbonate, but not by chlorides or sulphates. Liming was therefore indicated as the proper method of dealing with the trouble. These observations appear to have been the first that were made on the subject; and they lead to a very complete study of the method of correcting acidity arising from the use of ammonium sulphate.

A further interesting feature is the prominence given to the use of seaweed as a manure. This subject attracts periodical attention, but very little progress has been made in the direction of utilisation, in spite of the enormous possibilities it seems to present. And yet the amount of fertilising material thrown up on our shores in the course of a year is enormous.

A pleasant feature of the book is the great prominence given to European work, Rothamsted experiments in particular coming in for a great amount of attention.

The book is very interesting and will be of considerable value to teachers and students of the subject. E. J. RUSSELL.

OUR BOOKSHELF.

Morocco the Piquant, or Life in Sunset Land. By G. E. Holt. Pp. xi + 242. (London: Wm. Heinemann, 1914.) Price 6*s*. net.

MR. HOLT, who seems to have held for about six years the post of American vice- and deputy-consul-general at Tangier, enjoyed facilities of exploring the interior of Morocco denied to European diplomatists who exercise a more active and less disinterested influence on the affairs of that distracted country. The note of his book is the strange conflict of Oriental and Western culture so close to Europe. He gives in naïve fashion and with a breezy style a sketch of the cosmopolitan population of Tangier, where he is reminded everywhere of the Arabian Nights. He was able to visit that strange Alsatia within ten miles of Tangier, held by the turbulent Angheras; he interviewed the bandit Raisuli, whom the Spaniards, it is said, are now ready to take into their service, at his refuge Arzila.

Perhaps the best part of the book is the chapter describing the Djinn, or evil spirits, the primitive animistic belief over which Islam is only a veneer, and his visit to a peasant household, an industrious farmer and his capable wife, good specimens of the fine material in the population, and capable of regenerating this harassed land if only it were subjected to a decently efficient Government. An energetic observer, with his American ideas of hustle and the superiority of Western industrialism is not the best authority on a primitive culture like that of Morocco, and his observations do not go far beneath the surface. But the facts of the present system and the notes on popular superstitions will interest students of politics and folklore. In face of the recent defeat of the Senoussi by the Italians, we can scarcely accept the prediction that Europe is menaced by a Mohammedan rising in North Africa.

Elementary Logic. By A. Sidgwick. Pp. x + 250. (Cambridge University Press, 1914.) Price 3*s*. 6*d*. net.

AN excellent manual, combining an adequate account of the old logic with a good exposition of modern developments. As becomes a logician, Mr. Sidgwick divides his book into parts and smaller sections, with admirable system and sequence. Part i. deals with the syllogism in all its forms, also with induction and fallacies, in which matters the author follows Mill for the most part. Interesting illustrations are chosen, and the treatment renders the text as readable as circumstances allow. It is admittedly impossible to make "Barbara" and her associates look anything but dull, however they are dressed up; but logic (as Browning said of his own poetry) is "not a substitute for dominoes," so the student will no doubt struggle through. Mr. Sidgwick gets the dull part disposed of as quickly as thoroughness will allow. In Part ii. we reach the more interesting and "live" part. The modern point of view is adopted, and formal logic is shown to establish only validity and not truth, because there is always something assumed. Further, classes are man-made, not nature-made; and, as we cannot say all that can be said about *S*, *S* may be in one class in certain of its relations, and in another when others of its aspects are being considered. Briefly, truth is relative to purpose. And proof is never coercive. The new logical method is modest. It looks forward with confidence, however, to a "great increase in the effectiveness of an appeal to facts against the verbalism which springs from uncritical acceptance of the abstract laws of thought."

Natural Sines to every Second of Arc, and Eight places of Decimals. Computed by E. Gifford. (Manchester: Abel Heywood and Son, 1914.) Pp. 543. Price 15*s*.

ANY practical means of assisting the computer is to be welcomed, and this volume of natural sines to every second of arc, and to eight places of decimals, will be sure to have a considerable practical value, even to those who use machines. The sines to 10″ are those from the "Opus Palatinum of Rheticus" (published 1596); the sines to 1″ were interpolated by the Thomas calculating machine being copied to ten places. The table is arranged like Chambers' log tables, the figures to the right of the seconds being prefixed to each of the sets in the same horizontal line, except when the sets are dotted, when the first four digits are taken from the line below. Considering the laborious nature of, and the accuracy required in the construction of these tables, the compiler is to be heartily congratulated on the successful completion of the task.

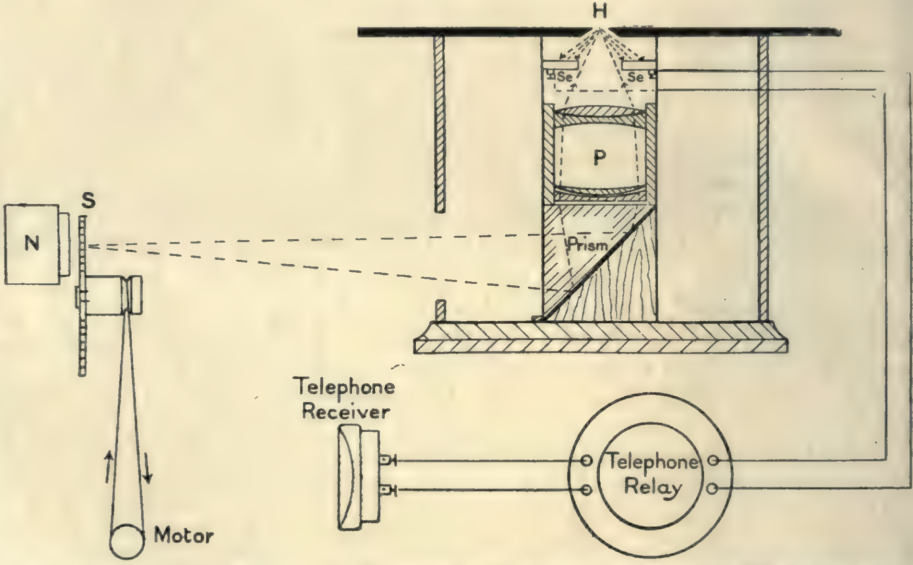
THE TYPE-READING OPTOPHONE.

ANY instrument designed for translating optical into acoustic effects, or light into sound, and thus to some extent substituting the ear for the eye, may be appropriately termed an "optophone." The intermediate link is either heat or electric current, and in view of the fact that a current of a few thousandths of a microampere is audible in the best modern telephones (if intermittent), one would naturally use an electrical rather than a thermal link. This is done in the various forms of "optophone" devised by the author since the Optical Convention of 1912.

The latest of these, described before the Royal Society on May 28, and shown at the conversazione of the society on June 16, is designed with the object of enabling blind persons to "read" ordinary letterpress by means of the ear. The accompanying illustration of the optical arrangement is reproduced from the Royal Society paper by permission of the council.

An optical system throws the image of a glowing Nernst filament upon the printed paper, laid face downwards on a suitably perforated desk. This image is broken up into a series of seven or eight luminous dots, flashing with different musical frequencies, by means of a rotating siren disc placed immediately in front of the Nernst filament. Some light-sensitive preparation, preferably of selenium, is placed close to the type so as to receive whatever light is diffusely reflected by it. The size of the image is made to fit the size of type to be read, and a sensitive telephone is put in series with the selenium and a battery, or with one of S. G. Brown's telephone relays.

It has been found possible to obtain a "readable" sound from type of the ordinary newspaper size. The straight black stem of a letter produces silence, and a curved letter, such as S, produces in its passage a set of gradually changing notes which are characteristic of the letter, and cannot be mistaken even after only a few minutes' practice. To learn the entire alphabet in this way should be a matter of a few weeks or months, but the amount of practice required will vary very greatly from one person to another, as only a "musical" ear can readily detect the omission o certain notes from a given chord. Given an adequate alignment and line-changing mechanism there is no reason why, with sufficient practice ear-reading should not be almost as rapid as the ordinary reading at sight.



Type-reading optophone. N, Nernst lamp; S, rotating siren disc; P, portrait lens, throwing image of line of intermittent dots on the printed matter placed face downwards at H; Se, selenium preparation receiving diffusely reflected light.

The choice of type is, of course, unlimited There is no arbitrary element in the determination of the sounds required to represent the various letters, as each type will automatically produce its own characteristic sounds. With considerable practice, a blind person, thus trained to allocate certain notes to certain positions should be able to construct "instinctively" a visual (or tactile) image of any new or unfamilia letterpress type at the first hearing.

E. E. FOURNIER D'ALBE.

NOTES.

THE president of the Board of Trade has appointed committee to consider and advise as to the best means of obtaining for the use of British industry sufficient supplies of chemical products, colours, and yestuffs of kinds hitherto largely imported from ountries with which we are at present at war. The ommittee is constituted as follows:—Lord Haldane chairman), Dr. George T. Beilby, F.R.S., Dr. J. J. Dobbie, F.R.S., Mr. David Howard, Mr. Ivan Levintein, Prof. Raphael Meldola, F.R.S., Mr. Max Muspratt, Prof. W. H. Perkin, F.R.S., Mr. Milton Sharp, Sir Arthur J. Tedder, Mr. Joseph Turner, Mr. T. Tyrer, with Mr. John Anderson, of the National Health Insurance Commission, and a representative of the Board of Trade. The secretary of the committee is Mr. F. Gossling (of the Patent Office), to whom all communications should be addressed at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, E.C.

THE closing of the Baltic ports and shortage of labour in the Bordeaux district of France have greatly reduced the normal supply of pitprops. As the provision of an adequate supply of mining timber is of great importance, the Board of Agriculture and Fisheries, in cooperation with the English Forestry Association, are taking steps to stimulate the marketing of home-grown timber. The timbers most in demand are larch, Scotch pine, and spruce of 3-in. diameter and upwards at the small end, but small hardwood timbers, such as oak, coppice, and beech are used to some extent. The standard lengths of pitprops differ in the various districts. Owners of extensive woods who may have timber which they consider suitable for this purpose but are in doubt as to the best method of marketing it or of obtaining it with least damage to the future welfare of their plantations, are invited to communicate at once with the secretary of the Board of Agriculture and Fisheries, or with the secretary, English Forestry Association, Farnham Common, Slough, Buckinghamshire.

THE present crisis will affect the electrical industry on account of the shortage of carbons for arc lighting. There is only one works manufacturing carbons in this country, the great majority of carbons having been imported from Germany and Austria. France also exports carbons to England, and there is a small factory in Spain. A limited supply may be available from Spain, but no imports are, of course, available from Germany and Austria, and the French factory is situated in the heart of the fighting at Nancy. The only carbon factory in America cannot do more than supply American wants, even if it is able to do this, as America imports carbons largely from Germany. Public lighting as well as the electrical industry will suffer, owing to the neglect and refusal of electric lighting authorities to support the enterprise which twelve years ago started manufacturing carbons in this country. The Admiralty and certain other Government departments which have recognised for some time past the necessity of having a source of supply independent of foreign carbons are now reaping the reward of their foresight in being able to obtain their supplies in this country. The present output of the carbon works in question is not sufficient to supply more than one-tenth of the carbons required in this country, but a very different state of affairs would have been the case if the carbon works had been properly supported in the past, for, in this case, the works would by now have been at least three or four times their present size. We can only hope that sufficient support will be given to British-made carbons in the future to allow of the present works being extended sufficiently to meet at least all public lighting demands for this country.

WHILE continuing their excavations in the Piltdown gravel last week, Mr. Charles Dawson and Dr. A. Smith Woodward met with a second portion of a molar tooth of Mastodon larger and more characteristic than the fragment originally described. The new specimen agrees well with the teeth of *Mastodon arvernensis* found in the Red Crag of Suffolk, but it is merely a waterworn hindmost ridge, and is evidently a derived fossil of earlier date than the deposition of the Piltdown gravel itself.

Two important additions have been made to the exhibited collection of Ichthyosaurians in the British Museum (Natural History). A nearly complete skeleton of Ophthalmosaurus, collected with great skill by Mr. Alfred N. Leeds from the Oxford Clay of Peterborough, has been mounted on an iron framework with all the bones approximately in their original relative positions. It is thus possible to realise the shape and proportions of this reptile during life much more readily than can be done by an examination of the crushed specimens in slabs of rock. The closeness of the ribs immediately behind the shoulder-girdle is especially interesting. The vertebral column is stoutest at the hinder end of the abdominal region, and the downward prolongation in the lower lobe of the tail-fin is gracefully curved. The paddles must have been very flexible, with much cartilage between the ossifications, and the hind paddles are so small as to be almost rudimentary. A slab of Upper Lias from Holzmaden, Würtemberg, shows a complete skeleton of *Ichthyosaurus acutirostris* with the surrounding soft parts as a bituminous impression on the rock. The specimen is one of the finest examples of Mr. Bernhard Hauff's work in preparing such fossils. The triangular dorsal fin and the vertically extended tail-fin are clearly seen, and there are several structures in the dorsal region of the trunk which still need interpretation.

As already announced, in consequence of the war the Comité des Forges de France has been obliged to cancel all arrangements for an autumn meeting of the Iron and Steel Institute in France this year. In the circumstances, the council of the institute has decided that it would be advisable to postpone for the present the organisation of any alternative arrangements for an autumn meeting for the reading and discussion of papers. A number of papers have been submitted with a view to their presentation at the meeting which was to have been held at Paris, and the council proposes to print in the usual way advance copies of those papers approved for publication and to invite discussion thereon by correspondence. It is expected that the copies will be ready for issue about the second week in September.

THE following resolution has been passed by the Chadwick trustees.—That in view of the immense importance of encouraging in every way the promotion of careful sanitary organisation in the naval and military services during the present campaign, the Chadwick trustees have resolved under the powers conferred upon them under the scheme they administer to announce their intention to award at the close of this year the Chadwick gold medal and 50*l.* each to the naval and military medical officer respectively in the British service who shall have distinguished himself most in promoting the health of the men in the Navy and the Army. The nomination for such presentations to be, as provided by the terms of the trust, by the directors-general of the naval and military medical services respectively.

IN vol. viii., No. 6, of the *Philippine Journal of Science*, Mr. R. B. Bean discusses certain types among the inland tribes of Luzon and Mindanao. He postulates three distinct migrations from Europe: one from Europe direct, without mingling with intervening peoples, as represented by the almost pure European types in the heart of Luzon and Mindanao; one by way of India, in which the types are the Indian and the so-called Malay; and one from Arabia and North Africa, the Mohammedan of history. There is also evidence among the Ilongots of another European element migrating through Siberia, possibly through China, and also from Japan. The Australoid type may antedate the Negritos, it may have resulted from them by crossing with other types, or it may have been brought in with the other types in the mingling migrations of the Europeans.

IN their report on the ethnozoology of the Tewa Indians of New Mexico by Messrs. J. Henderson and I. P. Harrington, published as Bulletin 56 of the Bureau of American Ethnology, the writers give a striking picture of the changes in the environment and fauna of the region due to the advent of the white man. The land was originally well grassed, and supported a large head of varied game. On the introduction of great herds of cattle from Texas, the situation rapidly changed. The grasses disappeared under their tongues and hoofs, many species of vegetation vanished, the surface became denuded of humus, and the underlying stones and gravels were exposed. In one pueblo in Arizona bones of thirty-seven species of animals were discovered in the rubbish heaps; it is not probable that five of these could now be collected. The writers also show that the current belief which attributes to the Indians an almost magical power of discriminating and naming the varieties of plants and animals is erroneous. They do distinguish species more closely than the average white man without training in botany or zoology; but they naturally fail to recognise the more minute differences, many of which are microscopic.

A NUMBER of striking photographs of the norther or Lado, race of the white rhinoceros (*Rhinocer simus cottoni*) serve to illustrate the second instalme of notes on African big game, by Mr. Russell Robert in the August number of *Wild Life*, this portion als concluding the account of the African elephant.

THE *Egyptian Gazette* of August 12 announces t arrival at the Gizeh Zoological Gardens of a co signment of 118 animals from the Sudan, for the mo part presented by English and native donors, offici and otherwise. The series includes thirty-seven ma mals, sixty-six birds, and fifteen reptiles, representi forty species and races. Among the first is a ver monkey (*Cercopithecus pygerythrus*) from the Mo galla district, a species previously unknown north East Africa. The menagerie at Gizeh has also ceived a Mediterranean seal (*Monachus albiventer*), species formerly abundant on the coasts of the from which it takes its name, but now unknown the Egyptian coast west of Alexandria, although few still remain in Tunisian waters, while a stragg is from time to time taken in the Adriatic.

IN a useful article by Mr. R. C. Mo man in *Symons's Meteorological Magazine* August on the renewal of Antarctic explo tion and research, it is pointed out that t interest in this subject is shown by the fact that t plans of four specified expeditions have been bef the public for some time. A map has been prepa giving the positions where meteorological and ot observations have been made, and the number years over which they extend. This map shows t "only over one-third of the S. Polar area south 60° S., and extending in one instance only so far 78° 30′ S., have we even a general knowledge of climatic features throughout the year." A consid able part of the available data relates to summer c ditions only, and, as the author remarks, it i matter for congratulation that in the near future may look forward to a substantial addition to knowledge of the meteorology of those regions.

THE report of the Meteorological Committee for year ended March 31 shows that considerable chan have taken place, owing to a liberal increase of Parliamentary grant. Among the more import items may be mentioned (1) the institution of a gr of junior "professional" assistants (with Univer qualifications) for meteorological and geo-phys work. (2) The satisfactory termination of nego tions with the Scottish Meteorological Society; of the several advantages is the inclusion in one p lication of available climatological data for all p of the British Islands. (3) A notable improvement the reconstruction of the central ("Kew") obse tory, after the departure of the assistants belong to the National Physical Laboratory, and a consi able addition to the instrumental equipment. (4) establishment of a "weather station" at Falmo in conjunction with the Royal Cornwall Polytec Society, in place of the photographic recording servatory, for the purpose of special researches weather prediction, and the investigation of the u

It is satisfactory to note some improvement in rate of transmission of wireless reports; a wireless eiving apparatus has been installed at the office for sages forwarded from the Eiffel Tower. Comisons of the weather forecasts and storm warning grams for the United Kingdom with subsequent ather show that the percentage successes have been y satisfactory. As an appendix to Dr. Shaw's eresting report is reprinted a circular containing ful particulars relating to the international units measurement recently adopted

SOME interesting notes on the changes occurring uring the manufacture of tea are given in a paper by r. S. Sawamura in the Bulletin of the Imperial Central Agricultural Experiment Station of Japan. In e manufacture of green tea the oxidising enzymes the leaf are killed by steaming, but it is essential at the steaming should not be too far prolonged, herwise other enzymes, which play a part in the roduction of the aroma, are also destroyed, and the subsequent quality is impaired. The effect of rolling e leaves is to increase the easy solubility of the onstituents which give quality to the infusion, and t the same time desiccation of the leaves is also ccelerated owing to juice being pressed out from the terior of the cells. Experiments are also described showing the effect of different temperatures during the "firing" of the leaves.

AN interesting contribution to the study of the formation of hydrogen cyanide in plants is contained in paper by Prof. A. Jorissen in the Bulletin of the Royal Academy of Belgium (1914, p. 130). It is shown that citric acid in presence of oxidising agents and a trace of a nitrite gives rise to hydrogen cyanide, probably owing to the action of the nitrite on acetonedicarboxylic acid, which is the first product of the oxidation. In dilute solution and in sunlight it is shown that small quantities of ferrous or ferric salts can effect the preliminary oxidation of the citric acid, even ferrous bicarbonate being sufficient for the purpose. Citric acid is widely diffused in plants, and light, which brings about its oxidation in presence of traces of iron, is also well known to favour cyanogenesis. It is probable therefore that the above described synthesis of hydrogen cyanide is one which is realised in the actual plant in many instances.

THE success of the "Tee" process for the production of white salt from rock-salt gives occasion for an illustrated article in *Engineering* for August 21, descriptive of the works now in operation at Carrickfergus, in Ireland. In this process the rock-salt is fed into a gas-fired furnace, where it melts and runs from the furnace into a "bath." The bath contains a slagging chamber, on the floor of which the greater proportion of the impurities is deposited; the molten salt then reaches other two chambers in the bath, each containing a 3 in. wrought iron pipe with a number of ⅛ in. holes through which compressed air at a pressure of from 8 to 10 lb. per sq. in. is blown. The state of agitation into which this throws the molten salt results in a further deposit of slag in both chambers. The molten salt then passes slowly through a settling-chamber, thence to a reservoir, and finally through two tap-holes to the rotary pans. The rotary pans crystallise the molten salt in one operation by means of stationary rakes, the latter performing the function of agitating the rapidly-cooling molten salt in such a manner as to crystallise it, ready for the market, in various grades, and sized according to requirements. The total rated capacity of the three furnaces at Carrickfergus is 70 tons of refined salt in 24 hours. The whole operation is continuous, the salt being deposited in a finished state ready for the market within half-an-hour of coming out of the mine.

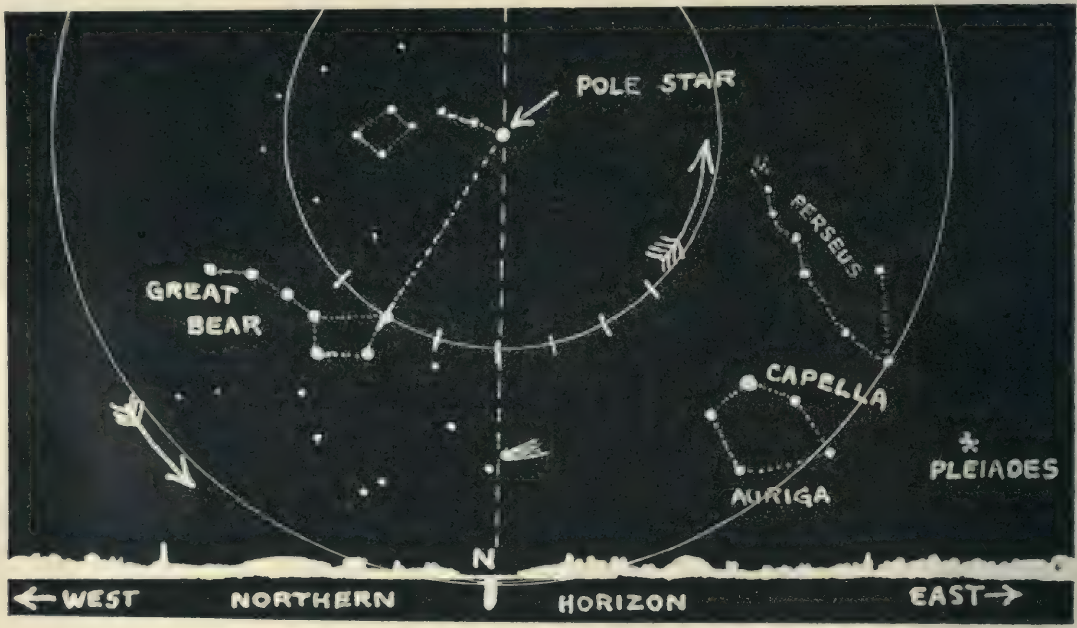
THE Cambridge University Press has added two further volumes to its series of Cambridge County Geographies, which when complete will cover the whole of the British Isles. One volume is on Glamorganshire, and is written by Mr. J. H. Wade; the other deals with Durham, and is by Mr. W. J. Weston. As in other cases, the books are brightly written, and give a readable account of the geography and geology of the areas, followed by a description of their economic resources and history. The maps, illustrations, and diagrams will maintain the high standard reached in previous volumes.

OUR ASTRONOMICAL COLUMN.

THE RECENT PERSEID SHOWER OF METEORS.—Mr. Denning reports that many observations from various stations have come to hand, and that the results are of a singularly interesting character. Though the shower was rather noteworthy for its brilliant meteors it was not exceptional as regards numbers. The fine weather which prevailed afforded some recompense for the moonlight. More than thirty bright meteors were observed at two stations or more, and their heights, radiants, and velocities have been found. The maximum occurred on August 11, but there were a few belated Perseids as late as August 20. One feature of the recent shower was that a number of fine meteors were not Perseids, but members of one or other of the many minor radiants which abound at this time of the year. The most conspicuous of these was in Lyra at 280°+44°, and there were others at 292°+51°, 312°+61°, 354°+77°, 309°+6°, and 74°+33°.

The last three showers were seen during the latter part of the month. The Aquilids at 309°+6° appear to form a new display, which, if it has been previously visible, seems to have eluded detection. The meteors are bright and move slowly in rather long flights. The display in Auriga at 74°+33° forms a pretty active display of swift conspicuous meteors leaving bright streaks. This shower was also seen on the morning of August 28, 1881, by Mr. Denning. He describes the meteors as being of very great velocity, and often having very extended flights across the firmament. A brilliant member of the stream was recorded on August 28 last at 10h. 25m. p.m., moving along a path of 84° from a few degrees N. of α Arietis, almost to the planet Jupiter. It was also seen from Kent, where its path was estimated as 100° long. It passed from over Kent to the English Channel about seventy-five miles S. of Portland Bill. Path, 182 miles, and velocity forty-five miles a second.

COMET 1913*f* (DELAVAN).—The accompanying chart is intended for the use of those who desire an easy means of finding Delavan's comet, which is now a conspicuous object in the night sky. In this chart the observer is supposed to be looking due north, *i.e.* towards the pole star, the star being easily found by the direction of the two pointers in the Great Bear. If a vertical line be imagined drawn through the pole star towards the horizon, then this line will approximately pass through the comet at about ten o'clock in the evening. While the comet has not a great altitude, it is well above the northern horizon, as shown in the chart. To the left of the comet is the constellation of the Great Bear, and well to the right (eastwards) is the constellation of Auriga with the bright star Capella. It should not be forgotten that, owing to the rotation of the earth, the constellations have an apparent motion round the pole star, as indicated by the arrows marked near the circles in the chart. During the night, therefore, the stars and the comet, as one faces northward, describe concentric circles round the pole star, and consequently the stars *under* Polaris move from left to right. The diagram thus clearly indicates that the later the comet is observed, the higher above the horizon it will be situated, and the *best* time to observe it is between two o'clock and four o'clock in the morning. The divided part of the smaller circle in the diagram shows approximately the hourly apparent movement of the stars.



The comet is a naked eye object, and is a fine sight as seen even with a pair of field glasses or a small telescope. In the earlier part of the night, when the comet is low down, the tail is nearly horizontal, stretching out towards the east. As the morning approaches, the tail becomes more inclined, the head then being at a lower altitude than the tail. The comet has a very dense, almost stellar nucleus and a considerable length of tail. On August 26 the nucleus was estimated (visually) as being about magnitude five, and the tail about one degree long, but on August 28 the tail was judged to be equal to about four lunar diameters, *i.e.* about two degrees in length, and the nucleus of magnitude three. There is little doubt that this object is being closely followed at all observatories. Some good photographs of the spectrum of the nucleus were secured during the early mornings of last week at the Hill Observatory, Sidmouth, with a prismatic camera of 12 in. aperture and a 20° prism.

RADIAL MOTION IN SUNSPOTS.—The subject of the radial motion in sunspots is referred to in three communications to the July number (vol. xi., No. 1) of the *Astrophysical Journal*. The first is contributed by Prof. W. H. Julius, and the position he takes up is "to defend the attacked position which is by no means so weak as he represents it" in the criticism of Mr. St. John of the anomalous dispersion theory in explaining the observed phenomena. Space does not permit one even to summarise Prof. Julius' conclusions, but it may be stated that the paper covers thirty-two pages, and concludes with eleven paragraphs of summary. The communications by Messrs. Evershed and St. John deal with the question of the limits of the radial motion. Mr. St. John's investigations indicated that the usual course of the displaced lines over spots showed no sharp break, and the displacement did not suddenly cease at the periphery of the penumbra, but the line gradually returned to its normal course. Mr. Evershed's view is that there is an appreciable break or jolt in the lines at the points where they pass from the penumbra on to the surrounding photosphere. The communications suggest that these different views are to some extent one of degree, and possibly due to the differences caused by the instrumental equipment of these investigators. Mr. St. John hopes to utilise the next maximum period of sunspots to make a special examination of this question, and a programme has already been planned.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY PROF. SIR THOMAS H. HOLLAND, K.C.I.E., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

EXACTLY eighty-three years from the day of our arrival at Sydney, Edward Suess was born in London. Thus the day, as much as the circumstances of our meeting so far from home, serves to remind us of one who was great enough to recognise the fact that geological evidence from any part of the world has the same value as that obtained in the little continent which has been the most prolific in the products of nomenclature and the most productive in text-books.

Since the days of Charles Lyell no geologist has been so conspicuously successful in analysing the accumulated mass of evidence, in bringing together the essential facts from all hands, and in compensating for the local excesses of literature. Only those of us who, by long absence from Europe, have felt the full disadvantages of having to express our thoughts in alien terminology can appreciate the real value of Suess's great work. His death since our last meeting makes a conspicuous mark in the history of geological science.

A meeting of the British Association in Australia brings home forcibly to the members of Section C the fact that British Imperial geology is really "the science of the earth"; partly for this reason one feels inclined to get outside the science and take a survey of some of its suburbs. Not many of them have been left untraversed by my distinguished predecessors in this chair; but there has been of recent years a tendency to avoid the inner earth, which has rightly been described as "the inalienable playground of the imagination," and consequently, therefore, common land to the geologist as well as the geodesist, physicist, and mathematician.

The geologist who looks below the purely superficial phenomena of the crust is generally regarded as straying beyond his province; but the desire to see the birth certificate of some of the strange and often unacceptable "causes" which the mathematical physicist offers us is a pardonable form of curiosity. Our ideas regarding intra-telluric conditions are even proving to be of economic value, one of the most recent and unexpected results of the kind being that just established by Baron von Eötvös in Hungary,[1] whose predictions now bid fair to outstrip those of the "diviner"! Having noticed the low gravity values over the great cores of rock-salt in the Transylvanian "Schlier," he finds similar defects of gravity in the same region over certain of the Sarmatian and Pontian domes, which probably owe their shape to subterranean salt-plugs and are now found to be great storehouses of natural gas, which, with or without liquid petroleum, is commonly found with the saline "Mediterranean" facies of the Upper Tertiary in Eastern Europe. Baron von Eötvös also finds that on the eastern margin of the Great Hungarian Plain, where the younger Tertiary beds are completely concealed by a mantle of alluvium, mud-volcanoes and gas-springs are sometimes found in areas of marked gravity defect, and some of these are now also being drilled for natural gas.

When our ideas of the state of affairs below the surface thus begin to yield economic results, there is hope that they are at last steadying down, becoming more settled, and indeed more "scientific." It may not be unprofitable, therefore, to review some of the advances recently made in developing theoretical conceptions regarding the interior of the earth that are of direct importance to geologists. In undertaking this review I am conscious of the fact that I shall be traversing ground that is generally familiar to all, and much of it the special property of specialists whose views I hesitate to summarise and should not dare to criticise. As the author of the "Ingoldsby Legends" said of the only story that Mrs. Peters would allow her husband to finish, "The subject, I fear me, is not over new, but will remind my friends—

"Of something better they have seen before."

The intensity and quantity of polemical literature on scientific problems frequently varies inversely as the number of direct observations on which the discussions are based: the number and variety of theories concerning a subject thus often form a coefficient of our ignorance. Beyond the superficial observations, direct and indirect, made by geologists, not extending below about one two-hundredth of the earth's radius, we have to trust to the deductions of mathematicians for our ideas regarding the interior of the earth; and they have provided us successively with every permutation and combination possible of the three physical states of matter—solid, liquid, and gaseous.

Starting, say, two centuries back with the astronomer Halley, geologists were presented with a globe of which the shell rotated at a rate different from that of its core. In more recent times this idea has been revived by Sir F. J. Evans (1878) to account for the secular variations in the declination of the magnetic needle.

Clairault's celebrated theorem (1743), on which Laplace based the most long-lived among many cosmogonies, gave us a globe of molten matter surrounded by a solid crust. Hopkins demanded a globe solid to the core, and, though his arguments were considered to be unsound, his conclusions have been revived on other grounds; while the high rigidity of the earth as a body has been maintained by Lord Kelvin, Sir George Darwin, Prof. Newcomb, Dr. Rudski, and especially by the recent observations of Dr. O. Hecker, supplemented by the mathematical reasoning of Prof. A. E. H. Love. Hennessy (1886), however, concluded that the astronomical demands could be satisfied by the old-fashioned molten earth in which the heavier substances conformed to the equatorial belt.

As long ago as 1858 Herbert Spencer suggested that, on account of its temperature being probably above the critical temperature of known elements, the centre of the earth is possibly gaseous. Late in the seventies Dr. Ritter revived the idea of a gaseous core surrounded by a solid crust, and this was modified in 1900 by the Swedish philosopher, Svante Arrhenius, whose globe with a solid crust, liquid substratum, and gaseous core is now a favourite among some geologists.

Wiechert (1897) supposed that the core of the earth, some 5,000 kilometres in radius, is composed mostly of iron with a density of 7·8, while this is surrounded by a shell of lithoidal material having a density of about 3·0 to 3·4; and this great contrast in density is about that which distinguishes the iron meteorites generally from those of the stony class. Arrhenius also assumes that iron forms the main part of the central three-quarters, and he shows that this distribution of substance may still be consistent with his theory of a gaseous core; indeed, he not only imagines that the whole of the iron nucleus is gaseous, but also most of the siliceous shell, for he leaves only 5 per cent. of the radius as the depth of the solid and liquid shells combined.

But the variety of ideas does not end with theories on the present constitution of the globe. Poisson required the process of solidification to begin from the centre and to progress outwards, while other mathematicians had been happy with the Leibnitzian *consistentior status* as the first external slaggy crust. Since the days of Laplace all naturalists have been forced to accept the idea of a solar system formed by the cooling and condensation of a spheroidal gaseous nebula; and all except those geologists who have vainly searched for traces of the primeval crust have been happy in this belief.

Recently, however, Dr. F. R. Moulton and Prof. T. C. Chamberlin in America have brought together arguments from different points of view to construct the solar system by the aggregation of innumerable small bodies, "planetesimals," which have gathered into knots to form the planets. Thus, the earth is supposed to have grown gradually by the accretion of meteoritic matter, and even now, although the process has nearly ceased, it receives much meteoritic material from outside.

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[1] *Comptes rendus*, XVIIème Conf. de l'Assoc. Géodés. Internat. Hamburg, 1912, pp. 427, 437.

With the Chamberlin-Moulton theory there must have been a time when the gravity of the earth was insufficient to hold an atmosphere of any but the heavier gases, such as carbon dioxide; later, the earth became heavy enough to retain oxygen, then nitrogen, water-vapour, and helium; while even now it may not be sufficiently attractive to prevent the light and agile molecule of hydrogen from flying off into space. With the growth of the young globe, the compression towards the centre produced heat enough to melt the accumulated fragments of meteoritic matter, and the molten material thus formed welled out at the surface. Such volcanic action is supposed to have predominated at the surface until an appreciable atmosphere was formed, and became charged with water, when the now familiar processes of weathering, erosion, and deposition produced the film of "rust" which geologists know as sedimentary rocks.

With this last addition to the variegated array of theories about the physical condition of the earth and about its genealogy, the scientific world began again to settle down into serenity, comforted by the happy feeling that all at any rate agree in regarding the earth as a gradually cooling body, with many millions of years still before it. Then came the discovery of radium, and, with it at first, an assurance that geologists were justified in claiming a long past, to be followed by a longer future than the most optimistic philosopher had dared before to assume with our apparently limited store of earth-heat. Now, however, Prof. Joly warns us that if the deeper parts of the globe contain anything near the proportion of radio-active bodies found by him in the superficial rocks, we may even be tending in the other direction; that, instead of a peaceful cooling, our descendants may have to face a catastrophic heating; the now inconspicuous little body known as the earth may indeed yet become famous through the universe as a new star.[2]

To add to the variety of ideas regarding the present state of the earth's interior, Prof. Schwarz, of Grahamstown,[3] concludes that our volcanic phenomena can be accounted for on the assumption that the main mass of the earth below a superficial layer is cold and solid throughout, being composed, like the meteorites, largely of unaltered ferromagnesian silicates and iron.

Thus, we see, whole fleets of hypotheses have been launched on this sea of controversy: some of the craft have been decoyed by the cipher-signals of the mathematician; some have foundered after bombardment by the heavy missiles classically reserved for use by militant geologists; others, though built in the dockyard of physicists, have suffered from the spontaneous combustion set up by an inadvertent shipment of radium. Still, some of these hypotheses are yet apparently seaworthy, and it may not be unprofitable to compare them with recently acquired data.

The nearest approach to actual observation with regard to the state of the earth's interior has been obtained by the seismograph, designed to record the movements of seismic waves at great distances from the disturbing earthquake. Some of the waves sent forth from an earthquake-centre travel through the earth, and some travel around by the superficial crust, the former reaching the distant seismograph before the latter. The seismograph, by its record of the waves that travel *through* the earth, has thus given a certain amount of information regarding the state of the earth's interior which R. D. Oldham aptly regards as analogous to that given by the spectroscope[4] with regard to the inaccessible atmosphere of the sun.

The existence of two groups of earthquake-waves—those passing through, and those passing near the surface around the earth—has long been recognised; but R. D. Oldham[5] has shown that the waves passing through the earth are of two kinds, travelling at two different speeds.

The record on the distant seismograph thus shows three well-marked phases: the first phase, due to waves of compression passing through the earth's interior; the second phase, due to waves of distortion,[6] also passing through the earth's interior; and the third phase, recorded by the waves which pass around the arc along the superficial crust.

The third phase is always recorded at a time after the occurrence of the shock proportional to the arcual distance of the recording seismograph from the earthquake centre, the records of several large earthquakes showing an average speed for the waves of about three kilometres a second. The rates of propagation of the waves giving the first and second phases are both much greater than of those forming the third phase; and up to an arcual distance of about 120° from the earthquake's centre the rate of their propagation increases with the distance. It is thus assumed that the waves giving rise to the first and second phases in each distant seismographic record, by following approximately along the chord of the arc between the place of origin and the instrument, pass through deeper layers of the earth when the seismograph is farther away, the material at greater depths being presumably more elastic as well as denser.

But Oldham[7] has shown that when the seismograph is as much as 150° from the earthquake centre there is a remarkable decrease in the mean apparent rate of propagation of the waves giving the second phase in the record, from more than six to about four and a half kilometres a second. There is also a drop, although not nearly so marked, in the apparent speed of the waves of the first phase when transmitted to a seismograph 150° or more distant from the earthquake origin. Oldham concludes that this decrease of apparent rate for waves travelling through the earth to places much more than 120° distant is due to their passing into a central core, four-tenths of the radius in thickness, composed of matter which transmits the waves at a markedly slow speed. Thus the earthquake waves which emerge at a distance not greater than 120° from their origin do not enter this central core, while those which pass into the earth to a greater depth than six-tenths of the radius are supposed to be refracted on entering, and again on leaving, the postulated core, in which the rate of transmission of an elastic wave of distortion is very much slower than in the main mass of the earth around. In consequence of the refraction of these waves on passing through the central core, places situated at about 140° from an earthquake origin should be in partial shadow, due to the great dispersion of the distortional waves, and the few records made so far by seismographs thus situated with regard to great earthquakes show that there is either no, or at most a doubtful, record for the second phase, which is known to be due to the so-called distortional waves.

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[2] J. Joly, "Radio-activity and Geology," 1909, pp. 168–172.

[3] E. H. L. Schwarz, "Causal Geology," 1910.

[4] In his presidential address to the Geological Society of London in 1909, Prof. W. J. Sollas (Proc. Geol. Soc., 1900, p lxxxvii.) credits H. Benndorf (Mitth. Geol. Gesellsch. Wien, I., 1908, 336) with this pretty analogy, but Oldham has the precedence by just two years (*cf.* Quart. Journ. Geol. Soc., vol. lxii., 1906, p. 456).

[5] Phil. Trans., Ser. A., vol. cxciv. (1900), pp. 135–74.

[6] There is more complete agreement regarding the fact that two distinct sets of waves give rise to the so-called preliminary tremors indicated by a seismographic record than about the nature of the waves. Confer. R. D. Oldham, Phil. Trans., *loc. cit.*, and O. Fisher, Proc. Cambr. Phil. Soc., vol. xii., pp. 354–61.

[7] Quart. Journ. Geol. Soc., vol. lxii., pp. 456–475 (1906).

Oldham's deductions are based confessedly on a small number of earthquake records—he considered fourteen examples only—but the conclusions based on a small number of trustworthy records, from which variations due to the different methods of marking the phases are eliminated, are more trustworthy than those for which there are imperfect distant records as well as doubts regarding the exact times of the disturbances. If these observations, however, be confirmed by further records, we are justified in assuming that below the heterogeneous crust there is a thick shell of elastic material, fairly homogeneous to about six-tenths of the radius, surrounding a central core, four-tenths in thickness, which possesses physical properties utterly unlike those of the outer layers; for in this core the "distortional" waves are either damped completely or are transmitted at very much lower speeds than in the shell.

One cannot consider this interesting inference from the seismographic data without being reminded of the contention of Ritter, Arrhenius, and Wilde regarding the possibility of a persistent gaseous core still above the critical temperature of the substances of which it is composed. According to Ritter,[8] the gaseous core is surrounded by a solid shell. Dr. Wilde[9] postulates the existence of a liquid substratum and a gaseous core within a solid crust, the two outer shells having a thickness that is "not very considerable." Arrhenius assumes from purely physical considerations that the solid crust is only about twenty-five miles thick, that below this it is possibly in a molten condition for about a hundred and fifty miles, and that the rest is a gas largely composed of iron under a pressure so great that its compressibility is not much less than that of steel.

The whole of these conclusions, being based on assumptions regarding the physical properties of matter under conditions of temperature and pressure that are well beyond those of actual experience, must be put on a plane of science well below that occupied by the investigations initiated by Oldham, who opens up a line of research in which, as said before, the seismograph may justifiably be compared with the spectroscope as an instrument for observing some inaccessible regions of nature.

The mathematician apparently finds it just as easy to prove that the earth is solid throughout as to show by extrapolation from known physical values that it must be largely gaseous. As Huxley said in his presidential address to the Geological Society in 1869, the mathematical mill is a mill which grinds you stuff of any degree of fineness, but, nevertheless, it can grind only what is put into it; and the seismograph thus offers a new source of substantial grist. Now that it is fairly certain that some of the earthquake-waves pass through the deeper parts of the earth, it is obvious that a fruitful development of science will follow successful efforts to introduce precision in recording, and uniformity of expression in reading, seismographic records.

Oldham[10] has pointed out another way in which analysis of seismographic records may lead to information regarding intra-telluric conditions by comparing the records of waves that pass under the oceanic depressions with those that are sub-continental for the whole or most of their paths. By comparing the records in Europe of the Colombian earthquake of January 31, 1906, with those of the San Francisco earthquake in the following April, there was a greater interval noticed between the first and second phases of the Californian earthquake—an interval greater than can be accounted for by mere difference of distance between the origin of the shock and the recording instruments. The seismic waves which passed from Colombia to Europe must have travelled under the broadest and deepest part of the North Atlantic basin, whilst those from California ran under the continent of North America, crossed the North Atlantic not far south of Iceland, and approached Europe from the north-west, the wave paths throughout being under continents or the continental shelf of the North Atlantic. There is thus suggested some difference between the elastic conditions of the sub-oceanic and the sub-continental parts of the crust—a difference which, judging by the particular instances discussed, may extend to a depth of one-quarter of the radius, but is not noticeable in the waves which penetrate to one-third of the radius below the surface.

Obviously these data must be multiplied many times before they can be regarded as a trustworthy index to a natural law; but it is significant that this indication of a difference between the physical nature of the sub-oceanic and sub-continental parts of the crust is in rough correspondence with the conclusions previously suggested on quite other grounds.

In his presidential address to the Geographical Section of the British Association at Dover in 1899, the late Sir John Murray directed attention to the chemical differentiation which has been going on between the continents and the oceans since the processes of weathering and denudation commenced. By these processes the more siliceous and specifically lighter constituents are left behind on the continents, while the heavier bases are carried out to the ocean. It is to this process that Prof. T. C. Chamberlin[11] also ascribes the origin of the depressions in which the oceanic waters have accumulated. As a corollary of the planetesimal theory, Chamberlin assumes that water began to be forced out of the porous surface blocks of the accumulated meteoritic material when the earth's radius was between 1500 and 1800 miles shorter than it is now; at that time pools of water began to be formed on the surface, and the atmosphere, just commencing its work, began the operation of leaching the heavier bases out of the highlands. Growth of the world proceeded by the infall of planetesimals, and while those meteorities that fell on the highlands became deprived of their soluble bases, those that fell into the young ocean were merely buried unaltered. Thus, by the time the earth reached its present size its crust under the oceanic depressions must have developed a chemical composition differing from that under the continents. According to the deduction suggested by Oldham from the seismographic records, there is a noticeable difference in the sub-oceanic areas to depths of between 1000 and 1300 miles—a layer in which the followers of Chamberlin's theory might reasonably expect some physical expression of the partially developed chemical differentiation.

The occurrence of denser material below the oceans has, of course, long been assumed from the deflection of the plumb-line, and was accepted by Pratt for his theory of compensation, as well as by Dutton as a wide expression of the theory of isostasy. Chamberlin[12] thus explains the general prevalence of basic lavas in oceanic volcanoes.

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[8] A. Ritter, "Untersuchungen über die Höhe der Atmosphäre und die Constitution gasformiger Weltkörper," Wiedemann's Ann. d. Phys. und Chem., vol. v. 405, 543 (1878); vol. vi. 135 (1879); vii. 304 (1879); vol. viii. 157 (1879).

[9] "On the Causes of the Phenomena of Terrestrial Magnetism," Pamphlet, 1890, p. 2. The idea that the Earth's magnetism is due to the electricity generated by the friction between the shell and the core, rotating with a different motion, was suggested by Dr. Wilde in 1902 (Mem. Manch. Lit. and Phil. Soc., vol. xlvi., part iv. p. 8, 1902). A similar suggestion based also on Halley's conception of a separately rotating inner core was made previously by Sir F. J. Evans in 1878 ("Remarkable Changes in the Earth's Magnetism," NATURE, vol. xviii. p. 80).

[10] Quart. Journ. Geol. Soc., vol. lxiii, 344–350 (1907).

[11] Chamberlin and Salisbury, "Geology," vol. ii. 1906, 106–111.

The apparent heterogeneity indicated in the outer shell of the earth to depths of 1000 miles is naturally in conflict with the assumption that from thirty miles or so down the materials are in a liquid condition; at any rate, the idea conflicts with Fisher's extreme conception of the liquid substratum, in which the fluidity is supposed to be sufficient for the production of convection currents, upwards beneath the oceanic depressions, spreading horizontally towards the continents, and thence downwards to complete the circuit.

The idea that changes of azimuth and of latitude may be brought about by the sliding of the earth's crust over its core has been put forward more than once to account for the climatic changes of past geological ages—the occurrence of temperate or even warm climates on parts of the crust now within the polar circles, and glacial conditions at the sea-level in countries like India, Australia, Africa, and South America, which are now far from the polar ice-sheets, and in some cases near or within the tropics. Prof. E. Koken, of Tübingen,[13] in an elaborate memoir entitled "Indisches Perm und die Permische Eiszeit," attributes the idea of a sliding crust to Mr. R. D. Oldham; but a similar suggestion was put forward by the late Sir John Evans twenty years before the publication of Mr. Oldham's paper,[14] and when the theory was restated in more precise form, ten years later,[15] it was subjected to mathematical criticism by J. F. Twisden, E. Hill, and O. Fisher.[16]

Sir John Evans suggested that this movement of the crust was inevitable as a consequence of the moulding of the orographical features and consequent redistribution of weights; but Twisden came to the conclusion that the rearrangement of the great inequalities on the earth's surface would be insufficient to produce any appreciable sliding of the order required to make material differences in the climate of any place.

Oldham,[17] who was writing at the time in the field in India and thus away from literature, put forward the idea in 1886 as an independent thought, and made use of Fisher's new theory regarding the existence of a fluid stratum between the solid crust and the supposed solid core to account for the shifting of places relative to the axis of rotation from the equatorial region even to the polar circles. Oldham directed attention to the recorded small changes of latitude at certain observatories and to the probable changes of azimuth in the Pyramids of Egypt—evidences of a kind which have since been greatly enlarged by the work of Sir Norman Lockyer and others.

The movements assumed to have taken place during the human period are of course small; and to project from them changes as great as the transfer of lands from the polar circle to the tropics has the objection that characterises a surveyor's use of "unfavourable" triangles in a trigonometrical survey. Before admitting, therefore, that these small changes of latitude and of azimuth may be classed with the palæoglacialists' evidence as data of the same kind, though so utterly different in magnitude, it is desirable briefly to examine the geological evidence regarding past ice-ages in extra-polar areas.

From the records of ancient glaciations we might omit those of the pre-Cambrian rocks of North Ontario, and the pre-Upper Cambrian of Norway, as these areas are nearer the poles than many places which were certainly covered with ice-sheets during the youngest, or often so-called Great, Ice Age. But besides these we have evidence of glaciation in the Cambrian or possibly pre-Cambrian rocks of South Australia at a latitude of 35° or less; in South Africa there were two or more distinct glacial periods before Lower Devonian times in slightly lower latitudes; while in China similar records are found among rocks of the Lower Cambrian, or possibly of older age, at a latitude of 31° N.

The glacial boulder-beds found at the base of our great coal-bearing system in India belong to the same stratigraphical horizon as the glacial beds found in South Africa, certain parts of Australia, and in parts of Brazil and São Paulo near or within the southern tropic.

These glacial beds are often referred to in geological literature as Permo-Carboniferous in age; but Prof. Koken regarded the formation in India as Permian. Other valuations of palæontological evidence, similar to that relied on by Prof. Koken, place these beds at a distinctly lower horizon in the European stratigraphical scale, and recent work by officers of the Geological Survey of India in Kashmir tends to confirm this latter view; we now regard the base of our great coal-bearing system in India—the horizon of the glacial-boulder-beds—as not much, if at all, younger than the Upper Coal Measures of Britain.[18] The precise age of the horizon is not very important for our present consideration: the important point is that in or near Upper Carboniferous times a widespread glaciation occurred throughout the area now occupied by India, Australia, and South Africa. The records of this great glaciation are thus found stretching northwards beyond the northern as well as southwards beyond the southern tropic.

Now, on the assumption that the cold climate in this region was due to a movement of the crust over the nucleus, Prof. Koken has produced an elaborate map of the World, showing the distribution of land and sea during the period, with the directions of ocean-currents and of ice-sheets. The Permian South Pole he places at the point of intersection of the present 20th parallel S. and 80th meridian E.—that is, at a point in the Indian Ocean about equidistant from the glaciated regions of India, Australia, and South Africa. The Permian North Pole is thus forced to take up its position in the centre of Mexico, while the Equator strikes through Russia, Italy, West Africa, down through the South Atlantic and round by Fiji to Vladivostock.

The very precision of this map reduces the theory on which it is based to a condition of unstable equilibrium. If glacial conditions were developed in India, Australia, and South Africa by a 70° movement of the crust, were the movements to and from its assumed position in Permian times so rapid that the glaciation of these widely separated areas appear to be geologically contemporaneous? If such movements had occurred, instead of evidences of glaciation over a wide area at the *same* period, we ought rather to find that the glaciation in each of the widely separated points occurred during distinctly *different* geological periods.

But that is not the only weak spot in the evidence. The Permian (or Permo-Carboniferous) glaciation of Australia took place on the east and south-east of the continent as well as in Western Australia, and the eastern ice-sheets would thus have been active within 30° of Prof. Koken's Permian equator. There are still three other serious pieces of colour-discord in this picture. In the State of São Paulo—that is, within Koken's "Permian" tropics—Dr. Orville Derby has described beds which strikingly recall the features of the Upper Palæozoic glacial beds of India and South Africa. It is possible that these are due to the work of glaciers at a high level; but, since the publication of Prof. Koken's memoir, other occurrences of the kind have been described by Dr. I. C. White in different parts of Brazil, and there is a general correspondence between the phenomena in South America and those in the formations of the same age in the Indian, Australian, and African regions.

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[12] "Geology," ii. 1906, p. 120.

[13] N. Jahrb. für. Min. u. s. w., 1907. 537.

[14] J. Evans, "On a Possible Geological Cause of Changes in the Position of the Axis of the Earth's Crust," Proc. Roy. Soc., xv. 46 (1866).

[15] J. Evans, Presidential Address, Proc. Geol. Soc., 1876, p. 105.

[16] J. F. Twisden, "On Possible Displacements of the Earth's Axis of figure produced by Elevations and Depressions of her Surface," Quart. Journ. Geol. Soc., xxxiv. 35 (1877). E. Hill, "On the Possibility of Changes in the Earth's Axis," *Geol. Mag.*, 1878, 262 and 479. O. Fisher, "On the Possibility of Changes in the Latitude of Places on the Earth's Surface," *Geol. Mag.*, 1878, pp. 291 and 551.

[17] *Geol. Mag.*, 1886, 304.

[18] H. H. Hayden, Rec. Geol. Surv. Ind., vol. vxxvi., p. 23, 1907.

Then, too, if we accept this expression of the physical geography during Upper Palæozoic times, we must carefully explain away the suspicious breccias and brockrams which have been regarded by many geologists as evidences of a cold climate during Permian times in the Urals, the Thüringerwald, the English midland and northern counties, Devonshire and Armagh—places that would lie on or near Koken's "Permian" equator. Finally, we find the hypothetical Permian North Pole in a locality which has failed to produce any signs of glaciation.

To attempt a discussion of the explanations offered to account for the great Upper Palæozoic glaciation would lead us far from the present theme. The question is raised merely to show that the phenomena are not consistent with the supposed movement of a solid shell over a solid core assisted by an intermediate molten lubricant. Geologists may be compelled to hand back the theory of a molten substratum to the mathematicians and physicists for further repair; but it does not necessarily follow that a foundation theory is unsound merely because it has been overloaded beyond its compressive strength.

The extraordinarily great distances between the areas that show signs of glaciation in Permo-Carboniferous times form a serious stumbling-block to most of the explanations which have hitherto been offered. One is almost tempted in despair even to ask if it is not possible that these fragments of the old Gondwana continent are now more widely separated from one another than they were in Upper Palæozoic times. It is a bold suggestion indeed that one can safely put aside as absurd in geomorphology. There is nothing else apparently left for us but the assumption of a general refrigeration.

The idea of the greater inequalities of the globe being in approximately static equilibrium has been recognised for many years: it was expressed by Babbage and Herschel; it was included in Archdeacon Pratt's theory of compensation; and it was accepted by Fisher as one of the fundamental facts on which his theory of mountain structure rested. But in 1889 Captain C. E. Dutton presented the idea "in a modified form, in a new dress, and in greater detail"; he gave the idea orthodox baptism and a name, which seems to be necessary for the respectable life of any scientific theory. "For the condition of equilibrium of figure, to which gravitation tends to reduce a planetary body, irrespective of whether it be homogeneous or not," Dutton[19] proposed "the name *isostasy*." The corresponding adjective would be isostatic—the state of balance between the ups and downs on the earth.

For a long time geologists were forced to content themselves with the conclusion that the folding of strata is the result of the crust collapsing on a cooling and shrinking core; but Fisher pointed out that the amount of radial shrinking could not account even for the present great surface inequalities of the lithosphere, without regard to the enormous lateral shortening indicated by the folds in great mountain regions, some of which, like the Himalayan folds, were formed at a late date in the earth's history, folds which in date and direction have no genetic relationship to G. H. Darwin's primitive wrinkles. Then, besides the folding and plication of the crust in some areas, we have to account for the undoubted stretching which it has suffered in other places, stretching of a kind indicated by faults so common that they are generally known as normal faults. It has been estimated by Claypole that the folding of the Appalachian range resulted in a horizontal compression of the strata to a belt less than 65 per cent. of the original breadth. According to Heim the diameter of the northern zone of the central Alps is not more than half the original extension of the strata when they were laid down in horizontal sheets. De la Beche, in his memoir on Devon and Cornwall, which anticipated many problems of more than local interest, pointed out that, if the inclined and folded strata were flattened out again, they would cover far more ground than that to which they are now restricted on the geological map. Thus, according to Dutton, Fisher, and others, the mere contraction of the cooling globe is insufficient to account for our great rock-folds, especially great folds like those of the Alps and the Himalayas, which have been produced in quite late geological times. It is possible that this conclusion is in the main true; but in coming to this conclusion we must give due value to the number of patches which have been let into the old crustal envelope—masses of igneous rock, mineral veins and hydrated products which have been formed in areas of temporary stretching, and have remained as permanent additions to the crust, increasing the size and bagginess of the old coat, which, since the discovery of radium, is now regarded as much older than was formerly imagined by non-geological members of the scientific world.

The peculiar nature of rock-folds presents also an obstacle no less formidable from the qualitative point of view. If the skin were merely collapsing on its shrinking core we should expect wrinkles in all directions; yet we find great folded areas like the Himalayas stretching continuously for 1400 miles, with signs of a persistently directed overthrust from the north; or we have folded massss like the Appalachians of a similar order of magnitude stretching from Maine to Georgia, with an unmistakable compression in a north-west to south-east direction. The simple hypothesis of a collapsing crust is thus "quantitatively insufficient," according to Dutton, though this is still doubtful, and it is "qualitatively inapplicable," which is highly probable.

In addition to the facts that rock-folds are maintained over such great distances and that later folds are sometimes found to be superimposed on older ones, geologists have to account for the conditions which permit of the gradual accumulation of enormous thicknesses of strata without corresponding rise of the surface of deposition.

On the other hand, too, in folded regions there are exposures of beds superimposed on one another with a total thickness of many miles more than the height of any known mountain, and one is driven again to conclude that uplift has proceeded *pari passu* with the removal of the load through the erosive work of atmospheric agents.

It does not necessarily follow that these two processes are the direct result of loading in one case and of relief in the other; for slow subsidence gives rise to the conditions that favour deposition and the uplifting of a range results in the increased energy of eroding streams.

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[19] Dutton, "On Some of the Greater Problems of Physical Geology," Bull. Phil. Soc. Wash., xi., 53, 1889.

Thus there was a natural desire to see if Dutton's theory agreed with the variations of gravity. If the ups and downs are balanced, the apparently large mass of a mountain-range ought to be compensated by lightness of material in and below it. Dutton was aware of the fact that this was approximately true regarding the great continental plateaux and oceanic depressions; but he imagined that the balance was delicate enough to show up in a small hill-range of 3000 to 5000 feet.

The data required to test this theory, accumulated during the triangulation of the United States, have been made the subject of an elaborate analysis by J. F. Hayford and W. Bowie.[20] They find that, by adopting the hypothesis of isostatic compensation, the differences between the observed and computed deflections of the vertical caused by topographical inequalities are reduced to less than one-tenth of the mean values which they would have if no isostatic compensation existed. According to the hypothesis adopted, the inequalities of gravity are assumed to die out at some uniform depth, called the depth of compensation, below the mean sea-level. The columns of crust material standing above this horizon vary in length according to the topography, being relatively long in highlands and relatively short under the ocean. The shorter columns are supposed to be composed of denser material, so that the product of the length of each column by its mean density would be the same for all places. It was found that, by adopting 122 kilometres as the depth of compensation, the deflection anomalies were most effectually eliminated, but there still remained unexplained residuals or local anomalies of gravity to be accounted for.

Mr. G. K. Gilbert,[21] who was one of the earliest geologists to turn to account Dutton's theory of isostasy, has recently offered a plausible theory to account for these residual discrepancies between the observed deflections and those computed on the assumption of isostatic compensation to a depth of 122 kilometres. An attempt had already been made by Hayford and Bowie to correlate the distribution of anomalies with the main features of the geological map and with local changes in load that have occurred during comparatively recent geological times. For example, they considered the possibility of an increased load in the low Mississippi valley, where there has been in recent times a steady deposition of sediment, and therefore possibly the accumlation of mass slightly in advance of isostatic adjustment. One would expect in such a case that there would be locally shown a slight excess of gravity, but, on the contrary, there is a general prevalence of negative anomalies in this region. In the Appalachian region, on the other hand, where there has been during late geological times continuous erosion, with consequent unloading, one would expect that the gravity values would be lower, as isostatic compensation would naturally lag behind the loss of overburden; this, however, is also not the case, for over a greater part of the Appalachian region the anomalies are of the positive order. Similarly, in the north central region, where there has been since Pleistocene times a removal of a heavy ice-cap, there is still a general prevalence of positive anomalies.

These anomalies must, therefore, remain unexplained by any of the obvious phenomena at the command of the geologist. G. K. Gilbert now suggests that, while it may be true that the product of the length of the unit column by its mean density may be the same, the density variations within the column may be such as to give rise to different effects on the pendulum. If, for instance, one considers two columns of the same size and of exactly the same weight, with, in one case, the heavy material at a high level and in the other case with the heavy material a low level, the centre of gravity of the former column, being nearer the surface, will manifest itself with a greater pull on the pendulum; these columns would be, however, in isostatic adjustment.[22]

Gilbert's hypothesis thus differs slightly from the conception put forth by Hayford and Bowie; for Gilbert assumes that there is still appreciable heterogeneity in the more deep-seated parts of the earth, while Hayford and Bowie's hypothesis assumes that in the nuclear mass density anomalies have practically disappeared, and that there is below the depth of compensation an adjustment such as would exist in a mass composed of homogeneous concentric shells.

In order to make the Indian observations comparable with those of the United States as a test of the theory of isostasy, Major H. L. Crosthwait[23] has adopted Hayford's system of computation and has applied it to 102 latitude stations and 18 longitude stations in India. He finds that the unexplained residuals in India are far more pronounced than they are in the United States, or, in other words, it would appear that isostatic conditions are much more nearly realised in America than in India.

The number of observations considered in India is still too small for the formation of a detailed map of anomalies, but the country can be divided into broad areas which show that the mean anomalies are comparable with those of the United States only over the Indian peninsula, which, being a mass of rock practically undisturbed since early geological times, may be regarded safely as having approached isostatic equilibrium. To the north of the peninsula three districts form a wide band stretching west-north-westwards from Calcutta, with mean residual anomalies of a positive kind, while to the north of this band lies the Himalayan belt, in which there is always a large negative residual.

Colonel Burrard[24] has considered the Himalayan and sub-Himalayan anomalies in a special memoir, and comes to the conclusion that the gravity deficiency is altogether too great to be due to a simple geosynclinal depression filled with light alluvium such as we generally regard the Gangetic trough to be. He suggests that the rapid change in gravity values near the southern margin of the Himalayan mass can be explained only on the assumption of the existence of a deep and narrow rift in the sub-crust parallel to the general Himalayan axis of folding. A single large rift of the kind and size that Colonel Burrard postulates is a feature for which we have no exact parallel; but one must be careful not to be misled by the use of a term which, while conveying a definite mental impression to a mathematician, appears to be incongruous with our geological experience. There may be no such thing as a single large rift filled with light alluvial material, but it is possible that there may still be a series of deep-seated fissures that might afterwards become filled with mineral matter.

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[20] J. F. Hayford, "The Figure of the Earth and Isostasy,' U.S. Coast and Geodetic Survey, Washington, 1909. "Supplementary Investigation," Washington, 1910. See also "Science," New Series, vol. xxxiii., p. 199, 1911. J. F. Hayford and W. Bowie, "The Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," "U.S. Coast and Geodetic Survey Special Publication No. 10," Washington, 1912.

[21] "Interpretation of Anomalies of Gravity," "U.S. Geol. Surv. Professional Paper," 85-C, 1913, p. 29.

[22] It is interesting to note that the idea suggested by G. K. Gilbert in 1913 was partly anticipated by Major H. L. Crosthwait in 1912 ("Survey of India, Professional Paper," No. 13, p. 5). Major Crosthwait, in discussing the similar gravity anomalies in India, remarks parenthetically: "Assuming the doctrine of isostasy to hold, is it not possible that in any two columns of matter extending from the surface down to the depth of compensation there may be the same mass, and yet that the density may be very differently distributed in the two columns? These two columns, though in isostatic equilibrium, would act differently on the plumb-line owing to the unequal distribution of mass.

"The drawback to treating this subject by hard and fast mathematical formulæ is that we are introducing into a discussion of the constitution of the earth's crust a uniform method when, in reality, probably no uniformity exists."

[23] "Survey of India, Professional Paper," No. 13, 1912.

[24] "Survey of India, Professional Paper," No. 12, 1912.

With this conception of a rift or a series of rifts, Colonel Burrard is led to reverse the ordinary mechanical conception of Himalayan folding. Instead now of looking upon the folds as due to an overthrust from the north, he regards the corrugations to be the result of an under-creep of the sub-crust towards the north. Thus, according to this view, the Himalaya, instead of being pushed over like a gigantic rock-wave breaking on to the Indian *Horst*, is in reality being dragged away from the old peninsula, the depression between being filled up gradually by the Gangetic alluvium. So far as the purely stratigraphical features are concerned, the effect would be approximately the same whether there is a superficial overthrust of the covering strata or whether there is a deep-seated withdrawal of the basement which is well below the level of observation.

Since the Tibetan expedition of ten years ago we have been in possession of definite facts which show that to the north of the central crystalline axis of the Himalaya there lies a great basin of marine sediments forming a fairly complete record from Palæozoic to Tertiary times, representing the sediments which were laid down in the great central Eurasian ocean to which Suess gave the name *Tethys*. We have thus so far been regarding the central crystalline axis of the Himalaya as approximately coincident with the old northern coast-line of Gondwanaland; but, if Colonel Burrard's ideas be correct, the coastline must have been very much further to the south before the Himalayan folding began.

Representing what the Geological Survey of India regards as the orthodox view, Mr. H. H. Hayden[25] has directed attention to some conclusions which, from our present geological knowledge, appear to be strange and improbable in Colonel Burrard's conclusions, and he also offers alternative explanations for the admitted geodetic facts. Mr. Hayden suggests, for instance, that the depth of isostatic compensation may be quite different under the Himalayan belt from that under the regions to the south. His assumptions, however, in this respect are, as pointed out by Colonel G. P. Lenox Conyngham,[26] at variance with the whole theory of isostasy. Mr. Hayden then suggests that most of the excessive anomalies would disappear if we took into account the low specific gravity of the sub-Himalayan sands and gravels of Upper Tertiary age as well as of the Pleistocene and recent accumulations of similar material filling the Indo-Gangetic depression. It would not be at all inconsistent with our ideas derived from geology to regard the Gangetic trough as some three or four miles deep near its northern margin, thinning out gradually towards the undisturbed mass of the Indian peninsula, and Mr. R. D. Oldham,[27] with this view, has also calculated the effect of such a wedge of alluvial material of low specific gravity, coming to the conclusion that the rapid change in deflection, on passing from the Lower Himalaya southward towards the peninsula, can mainly be explained by the deficiency of mass in the alluvium itself.

It is obvious that, before seeking for any unusual cause for the gravity anomalies, we ought to take into account the effect of this large body of alluvium which lies along the southern foot of the range. It is, however, by no means certain that a thick mass of alluvial material, accumulated slowly and saturated with water largely charged with carbonate of lime, would have a specific gravity so appreciably lower than that of the rocks now exposed in the main mass of the Himalaya as to account for the residual anomalies. Some of the apparent deficiency in gravity is due to this body of alluvium, but it will only be after critical examination of the data and more precise computation that we shall be in a position to say if there is still room to entertain Colonel Burrard's very interesting hypothesis.

By bringing together the geological and geodetic results we notice five roughly parallel bands stretching across northern India. There is (1) a band of abnormal high gravity lying about 150 miles from the foot of the mountains, detected by the plumb-line and pendulum; (2) the great depression filled by the Gangetic alluvium; (3) the continuous band of Tertiary rock, forming the sub-Himalaya, and separated by a great boundary overthrust from (4) the main mass of the Outer and Central Himalaya of old unfossiliferous rock, with the snow-covered crystalline peaks flanked on the north by (5) the Tibetan basin of highly fossiliferous rocks formed in the great Eurasian mediterranean ocean that persisted up to nearly the end of Mesozoic times.

That these leading features in North India can scarcely be without generic relationship one to another is indicated by the geological history of the area. Until nearly the end of the Mesozoic era the line of crystalline, snow-covered peaks now forming the Central Himalaya was not far from the shore-line between Gondwanaland, stretching away to the south, and Tethys, the great Eurasian ocean. Near the end of Mesozoic times there commenced the great outwelling of the Deccan Trap, the remains of which, after geological ages of erosion, still cover an area of 200,000 square miles, with a thickness in places of nearly 5000 ft. Immediately after the outflow of this body of basic lava, greater in mass than any known eruption of the kind, the ocean flowed into North-West India and projected an arm eastwards to a little beyond the point at which the Ganges now emerges from the hills. Then followed the folding movements that culminated in the present Himalayan range, the elevation developing first on the Bengal side, and extending rapidly to the north-west until the folds extended in a great arc for some 1400 miles from south-east to north-west.

New streams developed on the southern face of the now rising mass, and although the arm of the sea that existed in early Tertiary times became choked with silt, the process of subsidence continued, and the gradually subsiding depression at the foot of the hills as fast as it developed became filled with silt, sand, gravel, and boulders in increasing quantities as the hills became mountains and the range finally reached its present dimensions, surpassing in size all other features of the kind on the face of the globe.

Now, it is important to remember that for ages before the great outburst of Deccan Trap occurred there was a continual unloading of Gondwanaland, and a continual consequent overloading of the ocean beds immediately to the north; that this process went on with a gradual rise on one side and a gradual depression on the other; and that somewhere near and parallel to the boundary line the crust must have been undergoing stresses which resulted in strain, and, as I suggest, the development of those fissures that let loose the floods of Deccan Trap and brought to an end the delicate isostatic balance.

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[25] "Rec. Geol Surv. Ind.," vol. xliii., part 2, p. 138, 1913.

[26] "Records of the Survey of India," vol. v., p. 1.

[27] Proc. Roy. Soc., Series A, vol. xc., p. 32, 1914.

During the secular subsidence of the northern shore line of Gondwanaland, accompanied by the slow accumulation of sediment near the shore and the gradual filing away of the land above sea-level, there must have been a gradual creep of the crust in a northerly direction. Near the west end of the Himalayan arc this movement would be towards the north-west for a part of the time; at the east end the creep would be towards the north-north-east and north-east. Thus there would be a tendency from well back in Palæozoic times up to the end of the Cretaceous period for normal faults—faults of tension—to develop on the land, with a trend varying from W.S.W.–E.N.E. to W.N.W.–E.S.E. across the northern part of Gondwanaland. We know nothing of the evidence now pigeon-holed below the great mantle of Gangetic alluvium, while the records of the Himalayan region have been masked or destroyed by later foldings. But in the stratified rocks lying just south of the southern margin of the great alluvial belt we find a common tendency for faults to strike in this way across the present Peninsula of India. These faults have, for instance, marked out the great belt of coalfields stretching for some 200 miles from east to west in the Damuda valley. On this, the east side of India, the fractures of tension have a general trend of W.N.W.–E.S.E. We know that these faults are later than the Permian period, but some of them certainly were not much later.

If now we go westwards across the Central Provinces and Central India into the eastern part of the Bombay Presidency, we find records of this kind still more strikingly preserved; for where the Gondwana rocks, ranging from Permo-Carboniferous to Liassic in age, rest on the much older Vindhyan series, we find three main series of these faults. One series was developed before Permo-Carboniferous times; another traverses the lower Gondwanas, which range up to about the end of Permian times; while the third set affects the younger and Upper Gondwanas of about Rhætic or Liassic age. Although the present topography of the country follows closely the outlines of the geological formations, it is clear from the work of the Geological Survey of India that these outlines were determined in Mesozoic times, and that the movements which formed the latest series of faults were but continuations of those which manifested themselves in Palæozoic times. According to Mr. J. G. Medlicott, the field data showed "that a tendency to yield in general east and west or more clearly north-east and south-west lines existed in this great area from the remote period of the Vindhyan fault." [28] The author of the memoir and map on this area was certainly not suspicious of the ideas of which I am now unburdening my mind; on the contrary, he attempted, and, with apologies, failed to reconcile his facts to views then being pushed by the weight of "authority" in Europe. This was not the last time that facts established in India were found (to use a field-geologist's term) unconformably to lie on a basement of geological orthodoxy as determined by authority in Europe. It is important to notice that the series of faults referred to in the central parts of India are not mere local dislocations, but have a general trend for more than 250 miles.

A fault must be younger, naturally, than the strata which it traverses, but how much younger can seldom be determined. Intrusive rocks of known age are thus often more useful in indicating the age of the fissures through which they have been injected, and consequently the dykes which were formed at the time of the eruption of the great Deccan Trap give another clue to the direction of stresses at this critical time, that is, towards the end of the Cretaceous period, when the northerly creep had reached its maximum, just before Gondwanaland was broken up. If, now, we turn to the geological maps of the northern part of Central India, the Central Provinces, and Bengal, we find that the old Vindhyan rocks of the Narbada valley were injected with hundreds of trap-dykes which show a general W.S.W.–E.N.E. trend, and thus parallel to the normal tension faults, which we know were formed during the periods preceding the outburst of the Deccan Trap. This general trend of faults and basic dykes is indicated on many of the published geological maps of India covering the northern part of the peninsula, including Ball's maps of the Ramgarh and Bokaro coalfields [29] and of the Hutar coalfield, [30] Hughes's Rewa Gondwana basin, [31] Jones's southern coalfields of the Satpura basin, [32] and Oldham's general map of the Son valley. [33]

We see, then, that the development of fissures with a general east-west trend in the northern part of Gondwanaland culminated at the end of the Cretaceous period, when they extended down, probably, to the basic magma lying below the crust either in a molten state, or in a state that would result in fluxion on the relief of pressure. That the molten material came to the surface in a superheated and liquid condition is shown by the way in which it has spread out in horizontal sheets over such enormous areas. Throughout this great expanse of lava there are no certain signs of volcanic centres no conical slopes around volcanic necks; and one might travel for more than 400 miles from Poona to Nagpur over sheets of lava which are still practically horizontal. There is nothing exactly like this to be seen elsewhere to-day. The nearest approach to it is among the Hawaiian calderas, where the highly mobile basic lavas also show the characters of superfusion, glowing, according to J. D. Dana, [34] with a white heat, that is, at a temperature not less than about 1300° C.

Mellard Reade has pointed out that the earth's crust is under conditions of stress analogous to those of a bent beam, with, at a certain depth, a "level of no strain." Above this level there should be a shell of compression, and under it a thicker shell of tension. The idea has been treated mathematically by C. Davison, G. H. Darwin, O. Fisher, and M. P. Rudski, and need not be discussed at present. Prof. R. A. Daly has taken advantage of this view concerning the distribution of stresses in the crust to explain the facility for the injection of dykes and batholiths from the liquid, or potentially liquid, gabbroid magma below into the shell of tension. [35] He also shows that the injection of large bodies of basic material into the shell of tension tends on purely mechanical grounds to the formation of a depression, or geosyncline. If this be so, are we justified in assuming that the heavy band following the southern margin of the Gangetic geosyncline is a "range" of such batholiths? The idea is not entirely new; for O. Fisher made the suggestion more than twenty years ago that the abnormal gravity at Kalianpur was due to "some peculiar influence (perhaps of a volcanic neck of basalt)." [36]

Daly's suggestion, however, taken into account with the history of Gondwanaland, may explain the peculiar alignment of the heavy subterranean band, parallel to the Gangetic depression and parallel to the general trend of the peninsular tension-faults and fissures that followed the unloading of Gondwanaland and the heavy loading of the adjoining ocean bed along a band roughly parallel to the present Himalayan folds.

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[28] "Mem. Geol. Surv. Ind.," vol. ii., 1860, part 2, p. 256.

[29] *Ibid.*, vol. vi., part 2.

[30] *Ibid.*, vol. xv.

[31] *Ibid.*, vol. xxi., part 3.

[32] *Ibid.*, vol. xxiv.

[33] *Ibid.*, vol. xxxi., part 1.

[34] "Characteristics of Volcanoes," 1891, p. 200.

[35] R. A. Daly, "Abyssal Igneous Injection as a Causal Condition and as an Effect of Mountain Building," *Amer. Journ. Sci.*, xxii., September, 1906, p. 205.

[36] "Physics of the Earth's Crust," 2nd ed., 1889, p. 216.

R. S. Woodward objected that isostasy does not seem to meet the requirements of geological continuity, for it tends rapidly towards stable equilibrium, and the crust ought therefore to reach a stage of repose early in geologic time.[37] If the process of denudation and rise, with adjoining deposition and subsidence, occurred on a solid globe, this objection might hold good. But it seems to me that the break-up of Gondwanaland and the tectonic revolutions that followed show how isostasy can defeat itself in the presence of a subcrustal magma actually molten or ready to liquefy on local relief of pressure. It is possible that the protracted filing off of Gondwanaland brought nearer the surface what was once the local level of no-strain and its accompanying shell of tension.

The conditions existing in northern Gondwanaland before late Mesozoic times must have been similar to those in south-west Scotland before the occurrence of the Tertiary eruptions, for the crust in this region was also torn by stresses in the S.W.–N.E. direction with the formation of a remarkable series of N.W.–S.E. dykes which give the 1-in. geological maps in this region a regularly striped appearance.

There is no section of the earth's surface which one can point to as being now subjected to exactly the same kind and magnitude of treatment as that to which Gondwanaland was exposed for long ages before the outburst of the Deccan Trap; but possibly the erosion of the Brazilian highlands and the deposition of the silt carried down by the Amazon, with its southern tributaries, and by the more eastern Araguay and Tocantins, may result in similar stresses which, if continued, will develop strains, and open the way for the subjacent magma to approach the surface or even to become extravasated, adding another to the small family of so-called fissure-eruptions.

The value of a generalisation can be tested best by its trustworthiness as a basis for prediction. Nothing shows up the shortcomings of our knowledge about the state of affairs below the superficial crust so effectually as our inability to make any useful predictions about earthquakes or volcanic eruptions. For many years to come in this department of science the only worker who will ever establish a claim to be called a prophet will be one in Cicero's sense—"he who guesses well."

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY PROF. ARTHUR DENDY, D.SC., F.R.S., PRESIDENT OF THE SECTION.

Progressive Evolution and the Origin of Species.

THE opening years of the present century have witnessed a remarkable development of biology as an experimental science, a development which, however full of promise it may be for the future, for the time being appears to have resulted in a widespread disturbance of ideas which have themselves only recently succeeded in gaining general acceptance. The theory of organic evolution, plainly enough enunciated at the close of the eighteenth and the beginning of the nineteenth century by Buffon, Lamarck, and Erasmus Darwin, remained unconvincing to the great majority of thinking men until the genius of Charles Darwin not only brought together and presented the evidence in such a manner that it could no longer be ignored, but elaborated a logical explanation of the way in which organic evolution might be supposed to have taken place. Thanks to his labours and those of Alfred Russel Wallace, supported by the powerful influence of such men as Huxley and Hooker, the theory was placed upon a firm foundation, in a position which can never again be assailed with any prospect of success.

This statement is, I believe, entirely justified with regard to the theory of organic evolution itself, but the case is very different when we come to investigate the position of the various subsidiary theories which have been put forward from time to time with regard to what may perhaps be termed the *modus operandi*, the means by which organic evolution has been effected. It is in this field that controversy rages more keenly than ever before. Lamarck told us that evolution was due to the accumulated results of individual effort in response to a changing environment, and also to the direct action of the environment upon the organism. Darwin and Wallace taught us that species originated by the natural selection of favourable variations, and under the influence of Weismann's doctrine of the non-inheritance of acquired characters the theory of natural selection is in danger of becoming crystallised into an inflexible dogma. In recent years De Vries has told us that species arise by sudden mutations, and not by slow successive changes, while one of the most extreme exponents of "Mendelism," Prof. Lotsy, lately informed us that all species arise by crossing, and seriously suggested that the vertebrate type arose by the crossing of two invertebrates!

This curious and many-sided divergence of opinion amongst expert biologists is undoubtedly largely due to the introduction of experimental methods into biological science. Such methods have proved very fruitful in results which at first sight seem to be mutually contradictory, and each group of workers has built up its own theory mainly on the basis of observations in its own restricted field.

Prof. Bateson has said in his recently published "Problems of Genetics": "When . . . we contemplate the problem of evolution at large the hope at the present time of constructing even a mental picture of that process grows weak almost to the point of vanishing. We are left wondering that so lately men in general, whether scientific or lay, were so easily satisfied. Our satisfaction, as we now see, was chiefly founded on ignorance."[1]

In view of this striking pronouncement on the part of one who has devoted his life with signal success to the experimental investigation of evolutionary problems, the remarks which I propose to lay before you for your consideration to-day may well appear rash and ill-advised. I cannot believe, however, that the position is really quite so black as it is painted. We must perforce admit that the divers theories with regard to the working of organic evolution cannot all be correct in all their details, but it may be that each contains its own elements of truth, and that if these elements can but be recognised and sorted out, they may perhaps be recombined in such a form as to afford at any rate a plausible working hypothesis. We must bear in mind from the outset that in dealing with such a complex problem many factors have to be taken into account, and that widely different views on the question may be merely one-sided and not necessarily mutually exclusive.

I take it there are three principal facts, or groups of facts, that have to be accounted for by any theory of organic evolution:—

(1) The fact that, on the whole, evolution has taken

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[37] "Address to the Sect. of Mathematics and Astronomy of the Amer. Assoc.," 1889. Smithsonian Report, 1890. p. 196.

[1] "Problems of Genetics," p. 97.

place in a progressive manner along definite and divergent lines.

(2) The fact that individual animals and plants are more or less precisely adapted in their organisation and in their behaviour to the conditions under which they have to live.

(3) The fact that evolution has resulted in the existence on the earth to-day of a vast number of more or less well-defined groups of animals and plants which we call species.

The first of these facts appears to me to be the most fundamental, and at the same time the one to which least attention is usually paid. The great question, after all, is, Why do organisms progress at all instead of remaining stationary from generation to generation? To answer this question it is not necessary to go back to the beginning and consider the case of the first terrestrial organisms, whatever they may have been, nor are we obliged to take as illustrations the lowest organisms known to us as existing at the present day. We may consider the problem at any stage of evolution, for at each stage progress is, or may be, still taking place. We may even begin by considering what is usually regarded as the highest stage of all, man himself; and indeed this seems the most natural thing to do, for we certainly know more about the conditions of progress in man than in any other organism. I refer, of course, at the moment, not to progress in bodily organisation, but to progress in the ordinary sense of the word, the progress, say, of a family which rises in the course of a few generations from a position of obscure poverty to one of wealth and influence. You may perhaps say that such a case has no bearing upon the problem of organic evolution in a state of nature, and that we ought to confine our attention to the evolution of bodily structure and function. If so, I must reply that you have no right to limit the meaning of the term evolution in this manner; the contrast between man and nature is purely arbitrary; man is himself a living organism, and all the improvements that he effects in his own condition are part of the progress of evolution in his particular case. At any rate I must ask you to accept this case as our first illustration of a principle that may be applied to organisms in general.

If we inquire into the cause of the progress of our human family I think there can be only one answer—it is due to the accumulation of capital, or, as I should prefer to put it, to the accumulation of potential energy, either in the form of material wealth or of education. What one generation saves is available for the next, and thus each succeeding generation gets a better start in life, and is able to rise a little higher than the preceding one.

Every biologist knows, of course, that there are many analogous cases amongst the lower animals, and also amongst plants. The accumulation of food-yolk in the egg has undoubtedly been one of the chief factors in the progressive evolution of animals, although it has been replaced in the highest forms by a more effective method of supplying potential energy to the developing offspring. It may indeed be laid down as a general law that each generation, whether of animals or of plants, accumulates more energy than it requires for its own maintenance, and uses the surplus to give the next generation a start in life. There is every reason to believe that this has been a progressive process throughout the whole course of evolution, for the higher the degree or organisation the more perfect do we find the arrangements for securing the welfare of the offspring.

We cannot, of course, trace this process back to its commencement, because we know nothing of the nature of the earliest living things, but we may pause for a moment to inquire whether any phenomena occur amongst simple unicellular organisms that throw any light upon the subject, What we want to know is—How did the habit of accumulating surplus energy and handing it on to the next generation first arise?

Students of Prof. H. S. Jennings's admirable work on the "Behaviour of the Lower Organisms" will remember that his experiments have led him to the conclusion that certain Protozoa, such as Stentor, are able to learn by experience how to make prompt and effective responses to certain stimuli; that after they have been stimulated in the same way a number of times they make the appropriate response at once without having to go through the whole process of trial and error by which it was first attained. In other words, they are able by practice to perform a given action with less expenditure of energy. Some modification of the protoplasm must take place which renders the performance of an act the easier the oftener it has been repeated. The same is, of course, true in the case of the higher animals, and we express the fact most simply by saying that the animal establishes habits. From the mechanistic point of view we might say that the use of the machine renders it more perfect and better adapted for its purpose. In the present state of our knowledge I think we cannot go beyond this, but must content ourselves with recognising the power of profiting by experience as a fundamental property of living protoplasm.

It appears to me that this power of profiting by experience lies at the root of our problem, and that in it we find a chief cause of progressive evolution. Jennings speaks of the principle involved here as the "Law of the readier resolution of physiological states after repetition," and, similarly, I think we must recognise a "Law of the accumulation of surplus energy" as resulting therefrom. Let us look at the case of the accumulation of food-yolk by the egg-cell a little more closely from this point of view. Every cell takes in a certain amount of potential energy in the form of food for its own use. If it leads an active life, either as an independent organism or as a constituent part of an organism, it may expend by far the greater part, possibly even the whole, of that energy upon its own requirements, but usually something is left over to be handed down to its immediate descendants. If, on the other hand, the cells exhibits very little activity and expends very little energy, while placed in an environment in which food is abundant, it will tend to accumulate surplus energy in excess of its own needs. Such is the case with the egg-cells of the multicellular animals and plants. Moreover, the oftener the process of absorbing food-material is repeated the easier does it become; in fact, the egg-cell establishes a habit of storing up reserve material or food-yolk. Inasmuch as it is a blastogenic character, there can be no objection to the supposition that this habit will be inherited by future generations of egg-cells. Indeed we are obliged to assume that this will be the case, for we know that the protoplasm of each succeeding generation of egg-cells is directly continuous with that of the preceding generation. We thus get at any rate a possibility of the progressive accumulation of potential energy in the germ-cells of successive generations of multicellular organisms, and, of course, the same argument holds good with regard to successive generations of Protista.

It would seem that progressive evolution must follow as a necessary result of the law of the accumulation of surplus energy in all cases where there is nothing to counteract that law, for each generation gets a better start than its predecessor, and is able to carry on a little further its struggle for existence with the environment. It may be said that this argument proves too much, that if it were correct all organisms would by this time have attained to a high degree of organisation, and that at any rate we should not expect to find such simple organisms as bacteria and Amœbæ still surviving. This objection, which, of course, applies equally to other theories of organic evolution, falls to the ground when we consider that there must be many factors of which we know nothing which may prevent the establishment of progressive habits and render impossible the accumulation of surplus energy. Many of the lower organisms, like many human beings, appear to have an inherent incapacity for progress, though it may be quite impossible for us to say to what that incapacity is due.

It will be observed that in the foregoing remarks I have concentrated attention upon the storing up of reserve material by the egg-cells, and in so doing have avoided the troublesome question of the inheritance of so-called acquired characters. I do not wish it to be supposed, however, that I regard this as the only direction in which the law of the accumulation of surplus energy can manifest itself, for I believe that the accumulation of surplus energy by the body may be quite as important as a factor in progressive evolution as the corresponding process in the germ-cells themselves. The parents, in the case of the higher animals, may supply surplus energy, in the form of nutriment or otherwise, to the offspring at all stages of its development, and the more capital the young animal receives the better will be its chances in life, and the better those of its own offspring.

In all these processes, no doubt, natural selection plays an important part, but, in dealing with the accumulation of food material by the egg-cells, one of my objects has been to show that progressive evolution would take place even if there were no such thing as natural selection, that the slow successive variations in this case are not chance variations, but due to a fundamental property of living protoplasm and necessarily cumulative.

Moreover, the accumulation of surplus energy in the form of food-yolk is only one of many habits which the protoplasm of the germ-cells may acquire in a cumulative manner. It may learn by practice to respond with increased promptitude and precision to other stimuli besides that of the presence of nutrient material in its environment. It may learn to secrete a protective membrane, to respond in a particular manner to the presence of a germ-cell of the opposite sex, and to divide in a particular manner after fertilisation has taken place.

Having thus endeavoured to account for the fact that progressive evolution actually occurs by attributing it primarily to the power possessed by living protoplasm of learning by experience and thus establishing habits by which it is able to respond more quickly to environmental stimuli, we have next to inquire what it is that determines the definite lines along which progress manifests itself.

Let us select one of these lines and investigate it as fully as the time at our disposal will permit, with the view of seeing whether it is possible to formulate a reasonable hypothesis as to how evolution may have taken place. Let us take the line which we believe has led up to the evolution of air-breathing vertebrates. The only direct evidence at our disposal in such a case is, of course, the evidence of palæontology, but I am going to ask you to allow me to set this evidence, which, as you know, is of an extremely fragmentary character, aside, and base my remarks upon the ontogenetic evidence, which, although indirect, will, I think, be found sufficient for our purpose. One reason for concentrating our attention upon this aspect of the problem is that I wish to show that the recapitulation of phylogenetic history in individual development is a logical necessity if evolution has really taken place.

We may legitimately take the nucleated Protozoon cell as our starting point, for, whatever may have been the course of evolution that led up to the cell, there can be no question that all the higher organisms actually start life in this condition.

We suppose, then, that our ancestral Protozoon acquired the habit of taking in food material in excess of its own requirements, and of dividing into two parts whenever it reached a certain maximum size. Here again we must, for the sake of simplicity, ignore the facts that even a Protozoon is by no means a simple organism, and that its division, usually at any rate, is a very complicated process. Each of the daughter-cells presently separates from its sister-cell and goes its own way as a complete individual, still a Protozoon. It seems not improbable that the separation may be due to the renewed stimulus of hunger, impelling each cell to wander actively in search of food. In some cases, however, the daughter-cells remain together and form a colony, and probably this habit has been rendered possible by a sufficient accumulation of surplus energy in the form of food-yolk on the part of the parent rendering it unnecessary for the daughter-cells to separate in search of food at such an early date. One of the forms of colony met with amongst existing Protozoa is the hollow sphere, as we see it, for example, in Sphærozoum and Volvox, and it is highly probable that the assumption of this form is due largely, if not entirely, to what are commonly called mathematical causes, though we are not in a position to say exactly what these causes may be. The widespread occurrence of the blastosphere or blastula stage in ontogeny is a sufficiently clear indication that the hollow, spherical Protozoon colony formed a stage in the evolution of the higher animals.

By the time our ancestral organism has reached this stage, and possibly even before, a new complication has arisen. The cells of which the colony is composed no longer remain all alike, but become differentiated, primarily into two groups, which we distinguish as somatic-cells and germ-cells respectively.

From this point onwards evolution ceases to be a really continuous process, but is broken up into a series of ontogenies, at the close of each of which the organism has to go back and make a fresh start in the unicellular condition, for the somatic cells sooner or later become exhausted in their conflict with the environment and perish, leaving the germ-cells behind to take up the running. That the germ-cells do not share the fate of the somatic cells must be attributed to the fact that they take no part in the struggle for existence to which the body is exposed. They simply multiply and absorb nutriment under the protection of the body, and therefore retain their potential energy unimpaired. They are in actual fact, as is so often said, equivalent to so many protozoa, and, like the protozoa, are endowed with a potential immortality.

We know that, if placed under suitable conditions, or in other words, if exposed to the proper environmental stimuli, these germ-cells will give rise to new organisms, like that in the body of which they were formerly enclosed. One of the necessary conditions is, with rare exceptions, the union of the germ-cells in pairs to form zygotes or fertilised ova; but I propose, in the first instance, for the sake of simplicity, to leave out of account the existence of the sexual process and the results that follow therefrom, postponing the consideration of these to a later stage of our inquiry. I wish, moreover, to make it quite clear that organic evolution must have taken place if no such event as amphimixis had ever occurred.

What, then, may the germ-cells be expected to do?

How are they going to begin their development? In endeavouring to answer this question we must remember that the behaviour of an organism at any moment depends upon two sets of factors—the nature of its own constitution on one hand, and the nature of its environment on the other. If these factors are identical for any two individual organisms, then the behaviour of these two individuals must be the same. If the germ-cells of any generation are identical with those of the preceding generation, and if they develop under identical conditions, then the soma of the one generation must also be identical with that of the other.[2] Inasmuch as they are parts of the same continuous germ-plasm—leaving out of account the complications introduced by amphimixis—we may assume that the germ-cells of the two generations are indeed identical in nearly every respect; but there will be a slight difference, due to the fact that those of the later generation will have inherited a rather larger supply of initial energy and a slightly greater facility for responding to stimuli of various kinds, for the gradual accumulation of these properties will have gone a stage further. The environment also will be very nearly identical in the two cases, for we know from experiment that if it were not the organism could not develop at all.

Throughout the whole course of its ontogeny the organism must repeat with approximate accuracy the stages passed through by its ancestors, because at every stage there will be an almost identical organism exposed to almost identical stimuli. We may, however, expect an acceleration of development and a slight additional progress at the end of ontogeny as the result of the operation of the law of the accumulation of surplus energy and of the slightly increased facility in responding to stimuli. The additional progress, of course, will probably be so slight that from one generation to the next we should be quite unable to detect it, and doubtless there will be frequent backslidings due to various causes.

We can thus formulate a perfectly reasonable explanation of how it is that the egg first undergoes segmentation and then gives rise to a blastula resembling a hollow protozoon colony; it does so simply because at every stage it must do what its ancestors did under like conditions. We can also see that progressive evolution must follow from the gradual accumulation of additions at the end of each ontogeny, these additions being rendered possible by the better start which each individual gets at the commencement of its career.

Let us now glance for a moment at the next stage in phylogeny, the conversion of the hollow spherical protozoon colony into the cœlenterate type of organisation, represented in ontogeny by the process of gastrulation. Here again it is probable that this process is explicable to a large extent upon mechanical principles. According to Rhumbler,[3] the migration of endoderm cells into the interior of the blastula is partly due to chemotaxis and partly to changes of surface tension, which decreases on the inner side of the vegetative cells owing to chemical changes set up in the blastocœl fluid.

We may, at this point, profitably ask the question, Is the endoderm thus formed an inherited feature of the organism? The material of which it is composed is, of course, derived from the egg-cell continuously by repeated cell-division, but the way in which that material is used by the organism depends upon the environment, and we know from experiment that modifications of the environment actually do produce corresponding modifications in the arrangement of the material. We know, for example, that the addition of salts of lithium to the water in which certain embryos are developing causes the endoderm to be protruded instead of invaginated, so that we get a kind of inside-out gastrula, the well-known lithium larva.

It appears, then that an organism really inherits from its parents two things: (1) a certain amount of protoplasm loaded with potential energy, with which to begin operations, and (2) an appropriate environment. Obviously the one is useless without the other. An egg cannot develop unless it is provided with the proper environment at every stage. Therefore, when we say that an organism inherits a particular character from its parents, all we mean is that it inherits the power to produce that character under the influence of certain environmental stimuli.[4] The inheritance of the environment is of at least as much importance as the inheritance of the material of which the organism is composed. The latter, indeed, is only inherited to a very small extent, for the amount of material in the egg-cell may be almost infinitesimal in comparison with the amount present in the adult, nearly the whole of which is captured from the environment and assimilated during ontogeny.

From this point of view the distinction between somatogenic and blastogenic characters really disappears, for all the characters of the adult organism are acquired afresh in each generation as a result of response to environmental stimuli during development. This is clearly indicated by the fact that you cannot change the stimuli without changing the result.

Time forbids us to discuss the phylogenetic stages through which the cœlenterate passed into the cœlomate type, the cœlomate into the chordate, and the chordate into the primitive vertebrate. We must admit that as yet we know nothing of the particular causes that determined the actual course of evolution at each successive stage. What we do know, however, about the influence of the environment, both upon the developing embryo and upon the adult, is sufficient to justify us in believing that every successive modification must have been due to a response on the part of the organism to some environmental change. Even if the external conditions remained practically identical throughout long periods of time, we must remember that the internal conditions would be different in each generation, because each generation starts with a slightly increased capital and carries on its development a little further under internal conditions modified accordingly.

At this point it may be asked, Is the response to environmental stimuli a purely mechanical one, and, if so, how can we account for the fact that at every stage in its evolution the organism is adapted to its environment? We shall have to return to this question later on, but it may be useful to point out once more that there is good reason to believe—especially from the experimental work of Jennings—that the response of even a unicellular organism to stimuli is to a large extent purposive; that the organism learns by experience, by a kind of process of trial and error, how to make the response most favourable to itself under any given change of conditions; in other words, that the organism selects those modes of response that are most conducive to its own well-being. Under the term response to stimuli we must, of course, include those responses of the living protoplasm which result in modifications of bodily structure, and hence the evolution of bodily structure will, on the whole, be of an adaptive character and will follow definite lines There is good reason for believing, however, that many minor modifications in structure may arise and persist, incidentally as it were, that have no significance as adaptations.

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[2] This is, of course, a familiar idea. Compare Driesch, "Gifford Lectures," 1907, p. 214.

[3] Quoted by Przibram, "Experimental Zoology," English Trans., Part i., p. 47.

[4] Compare Dr. Archdall Reid's suggestive essay on "Biological Terms" (*Bedrock*, January, 1914).

One of the most remarkable and distinctive features of the lower vertebrates is the presence of gill-slits as accessory organs of respiration. These gill-slits are clearly an adaptation to aquatic life. When the ancestors of the higher vertebrates left the water and took to life on land the gills disappeared and were replaced by lungs, adapted for air-breathing. The change must, of course, have been an extremely gradual one, and we get a very clear indication of how it took place in the surviving dipnoids, which have remained in this respect in an intermediate condition between the fishes and the amphibia, possessing and using both gills and lungs.

We also know that even the most highly specialised air-breathing vertebrates, which never live in water and never require gills or gill-slits at all, nevertheless possess very distinct gill-slits during a certain period of their development. This is one of the most familiar illustrations of the law of recapitulation, and my only excuse for bringing it forward now is that I wish, before going further, to consider a difficulty—perhaps more apparent than real—that arises in connection with such cases.

It might be argued that if gill-slits arose in response to the stimuli of aquatic life, and if these stimuli are no longer operative in the case of air-breathing vertebrates, then gill-slits ought not to be developed at any stage of their existence. This argument is, I think, fully met by the following considerations.

At any given moment of ontogenetic development the condition of any organ is merely the last term of a series of morphogenetic stages, while its environment at the same moment—which, of course, includes its relation to all the other organs of the body—is likewise merely the last term of a series of environmental stages. We have thus two parallel series of events to take into consideration in endeavouring to account for the condition of any part of an organism—or of the organism as a whole—at any period of its existence:—

$E_1\ E_2\ E_3$ … … … E_n environmental stages
$M_1\ M_2\ M_3$ … … … M_n morphogenetic ,,

Ontogeny is absolutely conditioned by the proper correlation of the stages of these two series at every point, and hence it is that any sudden change of environment is usually attended by disastrous consequences. Thus, after the fish-like ancestors of air-breathing vertebrates had left the water and become amphibians, they doubtless still had to go back to the water to lay their eggs, in order that the eggs might have the proper conditions for their development.

Obviously the environment can only be altered with extreme slowness, and one of the first duties of the parent is to provide for the developing offspring conditions as nearly as possible identical with those under which its own development took place. It is, however, inevitable that, as phylogenetic evolution progresses, the conditions under which the young organism develops should change. In the first place, the mere tendency to acceleration of development, to which we have already referred, must tend to dislocate the correlation between the ontogenetic series and the environmental series. Something of this kind seems to have taken place in the life-cycle of many hydrozoa, resulting in the suppression of the free medusoid generation and the gradual degeneration of the gonophore. But it is probably in most cases change in the environment of the adult that is responsible for such dislocation.

To return to the case of the amphibians. At the present day some amphibians, such as the newts and frogs, still lay their eggs in water, while the closely related salamanders retain them in the oviducts until they have developed into highly organised aquatic larvæ, or even what is practically the adult condition. Kammerer has shown that the period at which the young are born can be varied by changing the environment of the parent. In the absence of water the normally aquatic larvæ of the spotted salamander may be retained in the oviduct until they have lost their gills, and they are then born in the fully-developed condition, while, conversely, the alpine salamander, of which the young are normally born in the fully-developed state, without gills, may be made to deposit them prematurely in water in the larval, gill-bearing condition.

There can be no doubt that the ancestral amphibians laid their eggs in water in a completely undeveloped condition. The habit of retaining them in the body during their development must have arisen very gradually in the phylogenetic history of the salamanders, the period for which the young were retained growing gradually longer and longer. It is obvious that this change of habit involves a corresponding change in the environmental conditions under which the young develop, and in cases in which the young are not born until they have reached practically the adult condition this change directly affects practically the whole ontogeny. We may say that the series

$E_1\ E_2\ E_3$ … … … E_n has become
$E_1'\ E_2'\ E_3'$ … … … E_n'

and as the change of environment must produce its effect upon the developing organism the series

$M_1\ M_2\ M_3$ … … … M_n will have become
$M_1'\ M_2'\ M_3'$ … … … M_n'

We must remember that throughout the whole course of phylogenetic evolution this series is constantly lengthening, so that what was the adult condition at one time becomes an embryonic stage in future generations, and the series thus represents not only the ontogeny, but also, though in a more or less imperfect manner, the phylogeny of the organism.

The character of each stage in ontogeny must depend upon (1) the morphological and physiological constitution of the preceding stage, and (2) the nature of the environment in which development is taking place. We cannot, however, distinguish sharply between those two sets of factors, for, in a certain sense, the environment gradually becomes incorporated in the organism itself as development proceeds, each part contributing to the environment of all the remainder, and the influence of this internal portion of the environment ever becoming more and more important.

The whole process of evolution depends upon changes of environment taking place so gradually that the necessary self-adjustment of the organism at every stage is possible. In the case of our amphibia the eggs could possibly undergo the first stages of development, the preliminary segmentation, within the oviduct of the parent just as well as in the water, for in both cases they would be enclosed in their envelopes, and the morphological differences between the early stages in the two cases might be expected to be quite insignificant. But it must be the same at each term of the series, for each term is built upon the foundation of the preceding one, and the whole process takes place by slow and imperceptible degrees.

It is true that by the time we reach the formation of the vestigial gill-slits in the embyro of one of the higher vertebrates the environmental conditions are very different from those under which gill-slits were developed in their aquatic ancestors. But what then?

Are not the gill-slits also very different? The changed environment has had its effect. The gills themselves are never developed, and the gill-slits never become functional; moreover, they disappear completely at later stages of development, when the conditions of life become still more different and their presence would be actually detrimental to their possessor. The embyro with the vestigial gill-slits is, as a whole, perfectly well adapted to its environment, though the gill-slits themselves have ceased to be adaptive characters. They still appear because the environmental conditions, and especially the internal conditions, which have now become far more important than the external ones, are still such as to cause them to do so.

I think the chief difficulty in forming a mental picture of the manner in which evolution has taken place, and especially in accounting for the phenomenon of recapitulation in ontogeny, which is merely another aspect of the same problem, arises from attempting to take in too much at once. There is no difficulty in understanding how any particular stage is related to the corresponding stage in the previous generation, and the whole series of stages, whether looked at from the ontogenetic or from the phylogenetic point of view, can be nothing else but the sum of its successive terms.

It will be convenient, before going further, to sum up the results at which we have so far arrived from the point of view of the theory of heredity. We have as yet seen no reason to distinguish between somatogenic and blastogenic characters. All the characters of the adult animal are acquired during ontogeny as the result of the reaction of the organism to environmental stimuli, both internal and external. All that the organism actually inherits is a certain amount of protoplasm—endowed with a certain amount of energy—and a certain sequence of environmental conditions. In so far as these are identical in any two successive generations the final result must be identical also, the child must resemble the parent; in so far as they are different the child will differ from the parent, but the differences in environment cannot be very great without preventing development altogether.

So far, it is clear, there has been no need to think of the germ-cells as the bearers of material factors or determinants that are responsible for the appearance of particular characters in the adult organism; nor yet to suppose that they are, to use the phraseology of the mnemic theory of heredity, charged with the memories of past generations. They have been regarded as simple protoplasmic units, and the entire ontogeny has appeared as the necessary result of the reaction between the organism and its environment at each successive stage of development. This cannot, however, be a complete explanation of ontogeny, for if it were we should expect all eggs, when allowed to develop under the same conditions from start to finish, to give rise to the same adult form, and this we know is not the case. We know also, from observation and experiment, that the egg is in reality by no means a simple thing but an extremely complex one, and that different parts of the egg may be definitely correlated with corresponding parts of the adult body. It has been demonstrated in certain cases that the egg contains special organ-forming substances definitely located in the cytoplasm, and that if these are removed definite parts of the organism into which the egg develops will be missing. We know, also, that the nucleus of the germ-cell of either sex contains—at any rate, at certain periods—a number of perfectly well-defined bodies, the chromosomes, and these also have been definitely correlated in certain cases with special features of the adult organisation.

Before we can hope to complete our mental picture of the manner in which organic evolution has taken place, if only in outline, it is evident that we must be able to account for the great complexity of structure which the germ-cells themselves have managed to acquire, and also to form some idea of the effect of this complication upon the development of both the individual and the race.

We must consider the origin of cytoplasmic and nuclear complications of the egg separately, for they appear to be due fundamentally to two totally distinct sets of factors. In the first place we have to remember that during oogenesis the egg-cell grows to a relatively large size by absorbing nutrient material from the body in which it is enclosed. It is this nutrient material that is used for building up the deutoplasm or food-yolk. There is good reason for believing that the character of this nutrient material will change, during the course of evolution, *pari passu* with the changing character of the organism by which it is supplied. Doubtless the change is of a chemical nature, for we know from precipitin experiments that the body fluids of closely allied species, or even of the two sexes of the same species, do exhibit distinctly recognisable differences in chemical composition. It also appears highly probable, if not certain, from such experiments as those of Agar upon Simocephalus, that substances taken in with the food, which bring about conspicuous modifications of bodily structure, may at the same time be absorbed and stored up by the egg-cells so as to bring about corresponding changes in the adults into which the eggs develop.

There seems therefore to be no great difficulty in comprehending, at any rate in a general way, how the egg may become the repository of definite chemical substances, organ-forming substances if we like to call them so, possibly to be classed with the hormones and enzymes, which will influence the development in a particular manner as soon as the appropriate conditions arise.

Unfortunately, time will not allow of our following up this line of thought on the present occasion, but we may notice, before passing on, that with the accumulation of organ-forming substances in the egg we have introduced the possibility of changes in bodily structure, to whatever cause they may be due, being represented by correlated modifications in the germ-cells, and this is doubtless one of the reasons why the germ-cells of different animals are not all alike with regard to their potentialities of development.[5]

We now come to the question of how the nucleus of the germ-cell acquired its great complexity of structure. We are not concerned here with the origin of the differentiation into nucleus and cytoplasm and the respective parts played by the two in the life of the cell. The problem which we have to consider is the complication introduced by the sexual process, by the periodically recurring union of the germ-cells in pairs, or, as Weismann has termed it, amphimixis. This is well known to be essentially a nuclear phenomenon, in which the so-called chromatin substance is especially concerned, and it is a phenomenon which must have made its appearance at a very early stage of evolution, for it is exhibited in essentially the same manner alike in the higher plants and animals and in unicellular organisms.

Let us suppose, for the sake of argument, that when amphimixis first took place the chromatin of each germ-cell was homogeneous, but that it differed sightly in different germ cells of the same species as a result of exposure to slightly different conditions during its past history. What would be likely to happen when two different samples of chromatin came together in the zygote? The result would surely depend upon the interaction of the complex colloidal multimolecules of which the chromatin is composed. Various possibilities would arise. (1) The two samples might differ in such a way as to act as poisons to one another, disturbing each other's molecular equilibrium to such an extent that neither could survive. This is possibly what happens when an ovum is fertilised by a spermatozoon of a distinct species, though there are, of course, exceptions. (2) They might be so alike as to be able to amalgamate more or less completely, so that there would simply be an increase of chromatin of possibly more or less modified constitution. (3) They might continue to exist side by side, each maintaining its own individual character.

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[5] Compare Cunningham's "Hormone Theory" of Heredity ("Archiv für Entwicklungsmechanik der Organismen," Bd. xxvi., Heft 3).

In the third case the union of the two different samples would give rise to a mass of chromatin of twofold nature, and repetition of the process from generation to generation would, as Weismann has shown, result in ever-increasing heterogeneity, until the chromatin came to consist of a great number of different concrete particles, each of which might conceivably differ from all the others. But when two heterogeneous masses of chromatin meet in the zygote there may be all sorts of mutual attractions and repulsions between the different colloidal multimolecules, for all three of our supposed cases may arise simultaneously, and thus the results may become extremely complicated.

The chromatin of the germ-cells in all existing organisms is undoubtedly heterogeneous, and this heterogeneity may be to some extent visibly expressed in its arrangement in more or less multiform chromosomes during mitosis. We may provisionally accept Weismann's view that these chromosomes are themselves heterogeneous, being composed of chromomeres or ids, which in their turn are composed of determinants.

All this complexity of structure may be attributed to the effects of oft-repeated amphimixis, a view which is supported in the most striking manner by the fact that the nucleus in all ordinary somatic cells (in animals and in the diploid generation of plants) has a double set of chromosomes, one derived from the male and the other from the female parent, and by the well-known phenomenon of chromatin reduction which always precedes amphimixis.

When we approach the problem of heredity from the experimental side we get very strong evidence of the existence in the germ-plasm of definite material substances associated with the inheritance of special characters. Mendelian workers generally speak of these substances as factors, but the conception of factors is evidently closely akin to that of Weismann's hypothetical determinants. The cytological evidence fits in very well with the view that the factors in question may be definite material particles, and it is quite possible that such particles may have a specific chemical constitution to which their effects upon the developing organism are due.

From our point of view the interesting thing is the possibility that arises through the sexual process of the permutation and combination of different factors derived from different lines of descent. A germ-cell may receive additions to its collection of factors or be subject to subtractions therefrom, and in either case the resulting organism may be more or less conspicuously modified.

By applying the method of experimental hybridisation a most fruitful and apparently inexhaustible field of research has been opened up in this direction, in the development of which no one has taken a more active part than the present President of the British Association. There cannot be the slightest doubt that a vast number of characters are inherited in what is called the Mendelian manner, and, as they are capable of being separately inherited and interchanged with others by hybridisation, we are justified in believing that they are separately represented in the germ-cells by special factors. Important as this result is, I believe that at the present time there exists a distinct danger of exaggerating its significance. The fact that many new and apparently permanent combinations of characters may arise through hybridisation, and that the organisms thus produced have all the attributes of what we call distinct species, does not justify us in accepting the grotesque view—as it appears to me—that all species have arisen by crossing, or even the view that the organism is entirely built up of separately transmissible "unit characters."

Bateson tells us that "Baur has for example crossed species so unlike as *Antirrhinum majus* and *molle*, forms differing from each other in almost every feature of organisation." Surely the latter part of this statement cannot be correct, for after all *Antirrhinum majus* and *molle* are both snapdragons, and exhibit all the essential characters of snapdragons.

I think it is a most significant fact that the only characters which appear to be inherited in Mendelian fashion are comparatively trivial features of the organism which must have arisen during the last stages of phylogeny. This is necessarily the case, for any two organisms sufficiently nearly related to be capable of crossing are identical as regards the vast majority of their characters. It is only those few points in which they differ that remain to be experimented on. Moreover, the characters in question appear to be all non-adaptive, having no obvious relation to the environment and no particular value in the struggle for existence. They are clearly what Weismann calls blastogenic characters, originating in the germ-plasm, and are probably identical with the mutations of de Vries. These latter are apparently chromatin-determined characters, for, as Dr. Gates has recently shown in the case of Œnothera, mutation may result from abnormal distribution of the chromosomes in the reduction division.[6]

We have next to inquire whether or not the Mendelian results are really in any way inconsistent with the general theory of evolution outlined in the earlier part of this address. Here we are obviously face to face with the old dispute between epigenesis and preformation. The theory of ontogeny which I first put forward is clearly epigenetic in character, while the theory of unit characters, represented in the germ-cells by separate "factors," is scarcely less clearly a theory of preformation, and of course the conception of definite organ-forming substances in the cytoplasm falls under the same category. The point which I now wish to emphasise is that the ideas of epigenesis and preformation are not inconsistent with one another, and that, as a matter of fact, ontogenetic development is of a dual nature, an epigenesis modified by what is essentially preformation.

We have already dealt briefly with the question of organ-forming substances in the cytoplasm, and it must, I think, be clear that the existence of these is in no way incompatible with a fundamental epigenesis. We shall find directly that the same is true of Mendelian "factors" or Weismannian "determinants."

We have seen that it is possible to conceive of even a complex organism as inheriting nothing from its parent but a minute speck of protoplasm, endowed with potential energy, and a sequence of suitable environments, the interaction between the two bringing about a similar result in each succeeding generation, with a slow progressive evolution due to the operation of the law of accumulation of surplus energy. If any of the conditions of development are changed the result, as manifested in the organisation of the adult, must undergo a corresponding modification. Suppose that the chromatin substance of the zygote is partially modified in molecular constitution, perhaps by the direct action of the environment, as appears to happen in the case of Tower's experiments on mutation in the potato beetle, or by the introduction of a different sample of chromatin from another individual by hybridisation. What is the germ-plasm now going to do? When and how may the changes that have taken place in its constitution be expected to manifest themselves in the developing organism?

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[6] *Quarterly Journal of Microscopical Science*, vol. lix., p. 557

Let us consider what would be likely to happen in the first stages of ontogeny. If the germ-plasm had remained unaltered the zygote would have divided into blastomeres under the stimuli of the same conditions, both internal and external, as those under which the corresponding divisions took place in preceding generations. Is the presence of a number of new colloidal multimolecules in the germ-plasm going to prevent this? The answer to this question probably depends partly upon the proportion that the new multimolecules bear to the whole mass, and partly upon the nature of the modification that has taken place. If the existence of the new multimolecules is incompatible with the proper functional activity of the germ-plasm as a whole there is an end of the matter. The organism does not develop. If it is not incompatible we must suppose that the zygote begins its development as before, but that sooner or later the modification of the germ-plasm will manifest itself in the developing organism, in the first instance as a mutation. In cases of hybridisation we may get a mixture in varying degrees of the distinguishing characters of the two parent forms, or we may get complete dominance of one form over the other in the hybrid generation, or we may even get some new form, the result depending on the mutual reactions of the different constituents of the germ-plasm.

The organism into which any zygote develops must be a composite body deriving its blastogenic characters from different sources; but this cannot affect its fundamental structure, for the two parents must have been alike in all essential respects or they could not have interbred, and any important differences in the germ-plasm must be confined to the "factors" for the differentiating characters. The fundamental structure still develops epigenetically on the basis of an essentially similar germ-plasm and under essentially similar conditions as in the case of each of the two parents, and there is no reason to suppose that special "factors" have anything to do with it.

We thus see how new unit characters may be added by mutation and interchanged by hybridisation while the fundamental constitution of the organism remains the same and the epigenetic course of development is not seriously affected. All characters that arise in this way must be regarded, from the point of view of the organism, as chance characters due to chance modifications of the germ-plasm, and they appear to have comparatively little influence upon the course of evolution.

One of the most remarkable features of organic evolution is that it results in the adaptation of the organism to its environment, and for this adaptation mutation and hybridisation utterly fail to account. Of course the argument of natural selection is called in to get over this difficulty. Those organisms which happen to exhibit favourable mutations will survive and hand on their advantages to the next generation, and so on. It has frequently been pointed out that this is not sufficient. Mutations occur in all directions, and the chances of a favourable one arising are extremely remote. Something more is wanted, and this something, it appears to me, is to be found in the direct response of the organism to environmental stimuli at all stages of development, whereby individual adaptation is secured, and this individual adaptation must arise again and again in each succeeding generation. Moreover, the adaptation must, as I pointed out before, tend to be progressive, for each successive generation builds upon a foundation of accumulated experience and has a better start than its predecessors.

Of course natural selection plays its part, as it must in all cases, even in the organic world, and I believe that in many cases—as, for example, in protective resemblance and mimicry—that part has been an extremely important one. But much more important than natural selection appears to me what Baldwin[7] has termed "Functional Selection," selection by the organism itself, out of a number of possible reactions, of just those that are required to meet any emergency. As Baldwin puts it, "It is the organism which secures from all its over-produced movements those which are adaptive and beneficial." Natural selection is here replaced by intelligent selection, for I think we must agree with Jennings[8] that we cannot make a distinction between the higher and the lower organisms in this respect, and that all purposive reactions, or adjustments, are essentially intelligent.

Surely that much-abused philosopher, Lamarck, was not far from the truth when he said, "The production of a new organ in an animal body results from a new requirement which continues to make itself felt, and from a new movement which this requirement begets and maintains."[9] Is not this merely another way of saying that the individual makes adaptive responses to environmental stimuli? Where so many people fall foul of Lamarck is with regard to his belief in the inheritance of acquired characters. But in speaking of acquired characters Lamarck did not refer to such modifications as mutilations; he was obviously talking of the gradual self-adjustment of the organism to its environment.

We are told, of course, that such adjustments will only be preserved so long as the environmental stimuli by which they were originally called for continue to exercise their influence. Those who raise this objection are apt to forget that this is exactly what happens in evolution, and that the *sine qua non* of development is the proper maintenance of the appropriate environment, both internal and external. Natural selection sees to it that the proper conditions are maintained within very narrow limits.

A great deal of the confusion that has arisen with regard to the question of the inheritance of acquired characters is undoubtedly due to the quite unjustifiable limitation of the idea of "inheritance" to which we have accustomed ourselves. The inheritance of the environment is, as I have already said, just as important as the inheritance of the material foundation of the body, and whether or not a newly acquired character will be inherited must depend, usually at any rate, upon whether or not the conditions under which it arose are inherited. It is the fashion nowadays to attach very little importance to somatogenic characters in discussing the problem of evolution. The whole fundamental structure of the body must, however, according to the epigenetic view, be due to the gradual accumulation of characters that arise as the result of the reactions of the organism to its environment, and are therefore somatogenic, at any rate in the first instance, though there is reason to believe that some of them may find expression in the germ-cells in the formation of organ-forming substances, and possibly in other ways. Blastogenic characters which actually originate in the germ-cells appear to be of quite secondary importance.

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[7] "Development and Evolution" (New York, 1902), p. 87.

[8] "Behaviour of the Lower Organisms" (New York, 1906), pp. 334, 335

[9] "Histoire naturelle des Animaux sans Vertèbres," tom. i., 1815, p. 185.

We still have to consider the question, How is it that organic evolution has led to the formation of those more or less well-marked groups of organisms which we call species? We have to note in the first place that there is no unanimity of opinion amongst biologists as to what a species is. Lamarck insisted that nature recognises no such things as species, and a great many people at the present day are, I think, still of the same opinion. In practice, however, every naturalist knows that there are natural groups to which the vast majority of individuals can be assigned without any serious difficulty. Charles Darwin maintained that such groups arose, under the influence of natural selection, through gradual divergent evolution and the extinction of intermediate forms. To-day we are told by de Vries that species originate as mutations which propagate themselves without alteration for a longer or shorter period, and by Lotsy that species originate by crossing of more or less distinct forms, though this latter theory leaves quite unsolved the problem of where the original forms that crossed with one another came from.

I think a little reflection will convince us that the origin of species is a different problem from that of the cause of progressive evolution. We can scarcely doubt, however, that Darwin was right in attributing prime importance to divergent evolution and the disappearance of connecting links. It is obvious that this process must give rise to more or less sharply separated groups of individuals to which the term species may be applied, and that the differences between these species must be attributed ultimately to differences in the response of the organism to differing conditions of the environment. It may be urged that inasmuch as different species are often found living side by side under identical conditions the differences between them cannot have arisen in this way, but we may be quite certain that if we knew enough of their past history we should find that their ancestors had not always lived under identical conditions.

The case of flightless birds on oceanic islands is particularly instructive in this connection. The only satisfactory way of explaining the existence of such birds is by supposing that their ancestors had well-developed wings, by the aid of which they made their way to the islands from some continental area. The conditions of the new environment led to the gradual disuse and consequent degeneration of the wings until they either became useless for flight or, in the case of the moas, completely disappeared. It would be absurd to maintain that any of the existing flightless birds are specifically identical with the ancestral flying forms from which they are descended, and it would, it appears to me, be equally absurd to suppose that the flightless species arose by mutation or by crossing, the same result being produced over and over again on different islands and in different groups of birds. This is clearly a case where the environment has determined the direction of evolution.

In such cases there is not the slightest ground for believing that crossing has had anything whatever to do with the origin of the different groups to which the term species is applied; indeed, the study of island faunas in general indicates very clearly that the *prevention* of crossing, by isolation, has been one of the chief factors in the divergence of lines of descent and the consequent multiplication of species, and Romanes clearly showed that even within the same geographical area an identical result may be produced by mutual sterility, which is the cause, rather than the result, of specific distinction.

Species, then, may clearly arise by divergent evolution under changing conditions of the environment, and may become separated from one another by the extinction of intermediate forms. The environmental stimuli (including, of course, the body as part of its own environment) may, however, act in two different ways: (1) Upon the body itself, at any stage of its development, tending to cause adaptation by individual selection of the most appropriate response; and (2) upon the germ-plasm, causing mutations or sudden changes, sports, in fact, which appear to have no direct relation whatever to the well-being of the organism in which they appear, but to be purely accidental. Such mutations are, of course, inherited, and, inasmuch as the great majority of specific characters appear to have no adaptive significance, it seems likely that mutation has had a great deal to do with the origin of species, though it may have had very little to do with progressive evolution.

Similarly with regard to hybridisation, we know that vast numbers of distinct forms, that breed true, may be produced in this way, but they are simply due to recombinations of mutational characters in the process of amphimixis, and have very little bearing upon the problem of evolution. If we like to call the new groups of individuals that originate thus "species," well and good, but it only means that we give that name, as a matter of convenience, to any group of closely related individuals which are distinguished by recognisable characters from the individuals of all other groups, and which hand on those characters to their descendants so long as the conditions remain the same. This, perhaps, is what we should do, and just as we have learnt to regard individuals as the temporary offspring of a continuous stream of germ-plasm, so we must regard species as the somewhat more permanent but nevertheless temporary offshoots of a continuous line of progressive evolution. Individuals are to species what the germ-plasm is to individuals. One species does not arise from another species, but from certain individuals in that species, and when all the individuals become so specialised as to lose their power of adaptation, then changes in the environment may result in the extinction of that line of descent.

It is scarcely necessary to point out that no explanation that we are able to give regarding the causes of either phylogenetic or ontogenetic evolution can be complete and exhaustive. Science can never hope to get to the bottom of things in any department of knowledge; there is always something remaining beyond our reach. If we are asked why an organism chooses the most appropriate response to any particular stimulus, we may suggest that this is the response that relieves it from further stimulation, but we cannot say how it learns to choose that response at once in preference to all others. If we are asked to account for some particular mutation, we may say that it is due to some modification in the constitution or distribution of the chromosomes in the germ-cells, but even if we knew exactly what that modification was, and could express it in chemical terms, we could not really say why it produces its particular result and no other, any more than the chemist can say why the combination of two gases that he calls oxygen and hydrogen gives rise to a liquid that he calls water.

There is one group of ontogenetic phenomena in particular that seems to defy all attempts at mechanistic interpretation. I refer to the phenomena of restitution, the power which an organism possesses of restoring the normal condition of the body after it has been violently disturbed by some external agent. The fact that a newt is able to regenerate its limbs over and over again after they have been removed, or that an echinoderm blastula may be cut in half and each half give rise to a perfect larva, is one of the most surprising things in the domain of biological science. We cannot, at present, at any rate, give any satisfactory mechanistic explanation of these facts, and to attribute them to the action of some hypothetical entelechy, after the manner of Prof. Hans Driesch, is simply an admission of our inability to do so. We can only say that in the course of its evolution each organism acquires an individuality or wholeness of its own, and that one of the fundamental properties of living organisms is to maintain that individuality. They are able to do this in a variety of ways, and can sometimes even replace a lost organ out of material quite different from that from which the organ in question is normally developed, as in the case of the regeneration of the lens of the eye from the iris in the newt. That there must be some mechanism involved in such cases is, of course, self-evident, and we know that that mechanism may sometimes go wrong and produce monstrous and unworkable results; but it is, I think, equally evident that the organism must possess some power of directing the course of events, so as generally to secure the appropriate result; and it is just this power of directing chemical and physical processes, and thus employing them in its own interests, that distinguishes a living organism from an inanimate object.

In conclusion I ought, perhaps, to apologise for the somewhat dogmatic tone of my remarks. I must ask you to believe, however, that this does not arise from any desire on my part to dogmatise, but merely from the necessity of compressing what I wished to say into a totally inadequate space. Many years of patient work are still needed before we can hope to solve, even approximately, the problem of organic evolution, but it seemed to me permissible, on the present occasion, to indulge in a general survey of the situation, and see how far it might be possible to reconcile conflicting views and bring together a number of ideas derived from many sources in one consistent theory.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—A course of twelve lectures on the theory and practice of radio-telegraphy will be delivered by Prof. J. A. Fleming at University College, on Wednesdays at 5 p.m., beginning October 28. The course will be in two parts, six lectures before Christmas and six between Christmas and Easter. It is open to both members and non-members of the University. It is intended for telegraphic engineers and electrical students who have already some elementary knowledge of the subject, and it will presume an elementary acquaintance with the differential calculus, and with the properties of vector quantities. The object of the course is to impart a more advanced knowledge of the theory and practice of wireless telegraphy in its modern form. University College is provided with an antenna and P.M.G. licence for its use.

THE High Commissioner for New Zealand announces that Dr. W. P. Gowland, of the University of Liverpool, has been appointed to the chair of anatomy at the University of Otago, Dunedin, New Zealand.

WE learn from the *Times* that the Senate of the National University of Ireland has passed the following resolution with reference to the destruction of the town of Louvain:—"The Senate of the National University of Ireland desires to offer to the illustrious University of Louvain its deep sympathy on the calamity which has befallen it—a calamity without parallel in history since the destruction of the Library of Alexandria. If this example prevail in warfare, then we may expect to find the records and achievements of civilisation extinguished by ignorance in arms. Therefore we appeal to the universities of all nations to unite in a protest against an act so disastrous to the progress of mankind."

THE Board of Agriculture and Fisheries has awarded research scholarships in agricultural and veterinary science of the annual value of 150*l.*, tenable for three years, to the following candidates, viz.:—*Agricultural Science*, J. Ll. Evans (Wales), S. M. Wadham (Cantab.), J. W. Munro (Edinburgh). *Veterinary Science*, R. Daubney, A. H. Adams. The Board has also awarded Mr. E. W. Jeffreys (Wales) an agricultural scholarship tenable for two years to fill a vacancy caused by the resignation of a scholar selected last year. The scholarships have been established in connection with the scheme for the promotion of scientific research in agriculture, for the purposes of which the Treasury have sanctioned grants to the Board from the Development Fund, and they are designed to provide for the training of promising students under suitable supervision with a view to enable them to contribute to the development of agricultural and veterinary science.

THE annual report of the Education Branch of the Board of Agriculture on the disposal of grants for agricultural education and research for the year 1913–14 shows that the Board is making satisfactory progress with its comprehensive scheme of organising agricultural work in the country. It has arranged for most of the universities to undertake special work in connection with the various counties which they serve, and, in addition, it supports a number of research institutes put up for the express purpose of investigating particular subjects. The whole scheme has been carefully planned to avoid overlapping; the report furnishes most interesting reading, and is a sufficient reply to the assertion sometimes made that British Government Departments can do nothing for scientific research. It is not claimed that the scheme is yet perfect; indeed, it is not yet in full working order, but it seems clear from the details furnished that things are going satisfactorily, and that the fully developed scheme will serve the purpose for which it was intended. Provision is made for higher agricultural education, the provision of technical advice for farmers, the investigation of local problems, and for carrying out agricultural research at institutions the function of which it is to develop subjects rather than to study set problems. The total amount of money granted during the year was 67,939*l.*, against 32,434*l.* last year.

THE calendar for 1914–15 of the Edinburgh and East of Scotland College of Agriculture has now been issued, and copies may be obtained from the secretary to the college, 13 George Square, Edinburgh. The college was founded in 1901 with the object of providing for agricultural education and research in the central and south-eastern counties of Scotland. The classes of the college are arranged in conjunction with certain classes in the science faculty of Edinburgh University, so as to provide a full course of teaching theoretical and practical, in agriculture and the allied sciences. This cooperation with the University has the further advantage that the courses for the diploma of the college and for the degree of B.Sc. of the University are concurrent. The calendar gives to intending students full guidance as to the curricula for the B.Sc. degree in agriculture and in forestry, the college diploma in agriculture, and the college certificate in horticulture. Particulars are also given of shorter courses which may be taken by those who are unable to spare time for sufficient attendance to gain the qualifications mentioned. Notes are included as to the locality and objects of the numerous experiments and demonstrations which are carried on in the grounds of the college. These are of special interest to the practical farmer, who is invited to consult the college staff in regard to his individual problems.

ADMIRAL SIR CYPRIAN BRIDGE, in a letter to the *Times* of August 29, comments on the notices published by the Vice-Chancellors of various universities announcing that due attention will be paid to the academic interests of students who have gone or are going to share in the defence of the country. The surprising thing, he says, is that university authorities should not have found themselves obliged to announce that as all their undergraduates above nineteen years of age and physically fit had joined the fighting forces of the Crown, their universities would be virtually empty until the need for fighting men was satisfied. Dr. A. E. Shipley, master of Christ's College, Cambridge, in a succeeding issue of our contemporary, points out that at Cambridge a considerable number will be left behind who are precluded by their age, physique, or physical condition from joining the forces. There are also foreigners in residence—sons of our allies—and it is hoped there will be more of these who, unfitted to fight, wish to continue their education. Dr. Shipley goes on to warn the public that all the young men who are not as yet in the Army or Navy are not shirkers. Some are not eligible for one reason or another, but are as anxious to serve their country as any man at the front. It is possible for zeal to outstrip justice and charity. Other correspondents point out that in the newer universities, half, or more than half, of the students are under the age of nineteen, and many are women. It is believed that in Oxford the number of undergraduates in residence next term will be reduced by about one-half, and that every university will provide large contingents of the Officers Training Corps for the service of the country.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 17.—M. P. Appell in the chair.—A. **Lacroix**: The non-volcanic basic rocks of Madagascar. The mineralogical and chemical composition of the basic rocks are dealt with in the present communication. Complete chemical analyses of twenty-two rocks are given.—Otto **Scheuer**: The action of the radium emanation upon detonating gas. The combination of hydrogen and oxygen is rapidly brought about by the radium emanation; in one experiment the mixture exploded. Both water and hydrogen peroxide are produced during the reaction, and it is probable that the latter is the primary product.—A. **Werner**: The optical activity of chemical compounds not containing carbon. An account of the preparation of the cobalt-amine salt, $[Co(OH)_2.Co(NH_3)_4]_3Br_6+2H_2O$, not containing carbon and possessing a specific rotatory power. The aqueous solution becomes inactive after two hours.—Paul **Pascal**: The rôle of valency in the additivity of diamagnetism.—N. A. **Barbieri**: The proximate analysis of wheat.—Gabriel **Bertrand** and Arthur **Compton**: A modification of amygdalinase and amygdalase due to age. Under the influence of time amygdalinase and amygdalase extracted from almonds lose their diastatic activity very slowly. The concentration of hydrogen ions most favourable to diastatic action increases with age.

CAPE TOWN.

Royal Society of South Africa, July 15.—Dr. L. Péringuey, president, in the chair.—L. **Péringuey**: Note on Palæolithic implements of large size found in the precincts of Cape Town city. The palæoliths are mostly of very large size and made of slate indurated by contact with the granite. They were discovered on the lower part of the talus of Signal Hill, within stone-throw of the houses built in this locality. It may be contended that natural agencies could have produced this amygdaloid form were it not for a few examples of "bouchers" found contiguously, and in which the artefact is patent. The locality is about 350 feet from the raised beach ledge which is now Green Point Common. These raised beaches will probably prove the means of obtaining ultimately a key to the age of many of the present geological features.—L. **Péringuey**: Note on grooved stone slabs, used by the Strand-Looper-San aboriginals. Search in undisturbed kitchen-midden deposits found so numerously within a sixty-mile radius of the littoral of the Union, seldom fails to reveal the presence of flat stones having a shallow artificial depression in the centre. Nor are these stones always restricted to this area. The depression is often found on each side. Speculations as to their having been used for sharpening blades of assegais or similar weapons are of course untenable. More likely was the theory of the stone having been utilised as a cooking-stone, the depression to receive the gravy.—K. H. **Barnard**: Exhibition of maine invertebrates. The discovery of the Siliceous sponge, *Regadrella phœnix,* from the deep water off East London, fills a gap in the hitherto known distribution of the species. *Aega monophthalma* and *Epimeria cornigera* were recorded for the first time in the southern hemisphere, a fact which bears on the theory of bipolarity.—E. J. **Goddard**: On the anatomy of *Ozobranchus branchiatus* and its position in the class Hirudinea. The paper deals with the somitic constitution and anatomy of *Ozobranchus branchiatus,* which must be one of the earliest forms of marine life taken in the Pacific Ocean. The species is, in addition to its historic interest, of significance in regard to its constitution, since it supports the suggestion previously made by the author, namely, that the Hirudinea and Arthropoda have been evolved from a common ancestor.—Paul A. van der **Bijl**: Preliminary investigation of the deterioration of maize infected with *Diplodia zeae* (Schw.) Lev. Maize infected with *Diplodia zeae* has a higher acidity than healthy maize. Infected maize gives Ori's reaction distinctly; it has a higher percentage of ash and of nitrogen.

CALCUTTA.

Asiatic Society of Bengal, August 5.—H. H. **Hayden**: Note on the application of the principle of isostatic compensation to the conditions prevailing beneath the Indo-Gangetic alluvium. This note has been written in reply to certain criticisms made by Col. G. P. Lenox Conyngham in "Records of the Survey of India," vol. v., on a paper published by the author in the "Records of the Geological Survey of India," vol. xliii., part 2, in which he discusses the evidence for a rift 20 miles deep extending all along the foot of or even under the Himalayas. The existence of such a rift was postulated by Col. Burrard to explain the anomalies observed in the deflection of the plumb line at certain stations in the Himalayas and in the plains south of them. The author reiterates his desire to reconcile the geodetic facts with the generally accepted theories as to the character of the alluvial depression south of the Himalayas—*i.e.*, a wedge-shaped mass with its thick end against the foot of the Himalayas shallowing to zero against the older rocks of the Peninsula—without discarding Dutton's theory of isostasy. He therefore endeavoured to show that by assuming other depths for complete isostatic compensation for India than 113·7 km.—that which Hayford had found to hold generally in the United States, the geodetic anomalies could be more easily explained, provided one was prepared to admit the possibility of the depth of isostatic compensation not being constant throughout the world. Reference is made to a recent paper by Mr. R. D. Oldham claiming to have proved by calculation that such a wedge-shaped trough filled with alluvium would be capable of producing just the observed anomalies, so that Col. Burrard's rift hypothesis becomes superfluous.—Barun Chandra **Dutt** and Surya Narayan **Sen**: Action of nitric oxide on metallic peroxides suspended in water. Part i. The authors have studied the action of nitric oxide on lead peroxide and barium peroxide suspended in water. They conclude from their experiments that in the case of lead peroxide both lead nitrite and lead nitrate are formed, whilst in the case of barium peroxide the only product of the reaction is barium nitrite. Experimental evidence is adduced to show that during the formation of the nitrite and nitrate of lead part of the lead peroxide is reduced to monoxide, and that lead nitrate is formed by the oxidizing action of lead peroxide on lead nitrate.—J. Sykes **Gamble**: Materials for a flora of the Malayan Peninsula No. 25. This part contains the families Nos. 96 (*bis*) Cytinaceæ and 109 Balanophoraceæ, both by Mr. H. N. Ridley; also Nos. 112 Juglandaceæ, 113 Myricaceæ, 114 Casuarinaceæ, 115 Fagaceæ, and 116 Salicaceæ, all by Mr. Gamble. In these seven families there are eleven genera and sixty-five species, of which one species in Balanophoraceæ, and eight in Fagaceæ are new. The new species have been described, with the usual Latin diagnoses, in the Kew Bulletin.—H. H. **Mann** and N. V. **Kanitkar**: Notes on the fat of *Garcinia indica*, the so-called Kokam butter. The present note supplements the information contained in D. Hooper's paper on the fats of Garcinia species (Journal, Asiatic Society of Bengal, vol. iii., page 257, published in 1907), but confines itself to Kokam butter, which is the fat of *Garcinia indica*. As already noted by Heise and Hooper, the fat is mainly oleo-distearin. The volatile fatty acids are a mixture of acetic and propisnic acids in practically equal proportions; butyric acid is absent.

BOOKS RECEIVED.

The Institute of Chemistry of Great Britain and Ireland. History of the Institute, 1877–1914. Compiled by R. B. Pilcher. Pp. iv+5–307. (London: Institute of Chemistry.)

Essays and Addresses by the late Prof. J. C. Brown. Pp. vii+208. (London: J. and A. Churchill.) 5*s.* net.

Records of the Western Australian Museum and Art Gallery. Vol. i. Part 3. Pp. 105–252 and plates. (Perth, W.A.) 5*s.*

Tasmania: Department of Mines. Geological Survey Bulletin No. 15:—The Stanley River Tin Field. By L. L. Waterhouse. Pp. vi+210; maps and sections to accompany above. (Hobart: J. Vail.)

The Royal Technical College, Glasgow. Calendar for the 119th Session, 1914–15. Pp. 508. (Glasgow: R. Anderson.)

Our Knowledge of the External World as a Field for Scientific Method in Philosophy. By B. Russell. Pp. vii+245. (Chicago and London: The Open Court Publishing Co.) 7*s.* 6*d.* net.

Matriculation Mechanics. By Drs. W. Biggs and G. H. Bryan. Ninth impression. (Third edition.) Pp. viii+363. (London: University Tutorial Press, Ltd.) 3*s.* 6*d.*

Guide to the Materials for American History, to 1783, in the Public Record Office of Great Britain. Vol. ii., Departmental and Miscellaneous Papers. By Prof. C. M. Andrews. Pp. viii+427. (Washington: Carnegie Institution.)

List of Prime Numbers from 1 to 10,006,721. By D. N. Lehmer. Pp. xv+133. (Washington: Carnegie Institution.)

Edinburgh and East of Scotland College of Agriculture. Calendar for 1914–15. Pp 148. (Edinburgh: Edinburgh and East of Scotland College of Agriculture.)

Seventh Annual Report of the American Bison Society. Pp. 72. (Groton, Mass.: American Bison Society.)

Metropolitan Water Board. Eighth Annual Report on the Results of the Chemical and Bacteriological Examination of the London Waters for the Twelve Months ended 31st March, 1914. Pp. 62. (London: C. Straker and Sons, Ltd.) 2*s.* 6*d.*

Metropolitan Water Board. Tenth Report on Research Work. Pp. 49. (London: C. Straker and Sons, Ltd.) 2*s.* 6*d.*

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THURSDAY, SEPTEMBER 10, 1914.

THE WAR—AND AFTER.

THE terrible war which is now raging, not only near our shores, but also much further afield, is teaching us many lessons, among them that the things which make most for a nation's life are apt not to be considered by the partisans of party politics. But it also shows that the British nation is sound enough at heart to throw off the trammels of party politics when a supreme moment arrives. Such a supreme moment is now on us and Britain is struggling for life with a foe who now shows his true colours. Many of us have been great admirers of Germany and German achievements along many lines, but we have now learned that her "culture" and admirable organisation have not been acquired, as we do not doubt was thought by the workers themselves, for the purpose of advancing knowledge and civilisation, but, in continuation of a settled policy, they have been fostered and used in order that a military caste in Germany, with the Kaiser at its head, shall ride roughshod over Europe, all treaties and national rights abrogated, all conventions set aside, all honour thrown to the winds, all laws of war and even of humanity disregarded. We are back in the days of the Huns. There is no doubt that in the complete plan of the great schemer the conquest and subsequent effacement of Britain were included.

Thank God, after many days of the most terrible fighting which the world has ever seen, it seems as if the day of the humiliation of France, which was to be the first stepping-stone to the final achievement, is not yet, and that before long the arch-plotter may be caught in the toils which he set for others. His final humiliation and overthrow are necessary for the world's peace, and will certainly come.

It is not for a scientific journal to chronicle the progress or to predict in detail the possible consequences of a war so brutally brought about, so brutally carried on by our enemy. Our task rather is to point out the importance not only of strengthening the troops in the field, but of seeing that our industries shall not suffer too greatly, for industry can alone supply in the long run the sinews of war for whatever period the conflict lasts; industry, moreover, to be most effective, must be broadly based on science.

In the latter direction the Government has taken a very wise step. The following communication has been issued from Downing Street:—

"Bearing in mind the sudden cessation of the oversea trade with Germany and Austria, the Secretary of State for the Colonies, with a view to alleviating to some extent the loss of business and employment both in the United Kingdom and the Colonies, telegraphed on the 15th inst. to some of the more important colonies not possessing responsible government to remind them that it is of the utmost importance to have full information up to date respecting the principal imports into each colony from Germany and Austria and as to the products of each colony hitherto exported to those countries. The Secretary of State has further desired that he should have by the earliest opportunity particulars as to the leading lines of articles of trade with Germany and Austria, illustrated by samples in the same way as was arranged in 1895.

"The Secretary of State has it in mind that action on the above lines will not only be an immediate benefit as regards employment in the United Kingdom, but should also lead to the permanent advantage of British trade in general.

"It is understood that the Trade Commissioners in the various self-governing Dominions are already kept closely in touch with the requirements of the trade in those Dominions, and collections of samples of different lines of goods in which British manufacturers might compete have recently been sent, or are on their way from certain parts of those Dominions.

"As regards neutral foreign countries the Secretary of State for Foreign Affairs has undertaken to send a similar request to his Majesty's Consuls in all places where such an inquiry is likely to have a useful result.

"The present intention of the Secretary of State for the Colonies is that, as soon as the samples from different parts of the Empire and from neutral countries are collected the traders and manufacturers of the United Kingdom shall have an opportunity of inspecting them in a central exhibition, possibly at the Imperial Institute. At any rate, no time will be lost in making suitable arrangements to carry out this intention."

"The Board of Trade are moving on the same lines, and have devised what promises to be a fruitful campaign for assisting British manufacturers and traders to take advantage of the war by establishing themselves, in neutral as well as Colonial markets, in those branches of business which have hitherto been largely in the hands of their German, Austrian, and Hungarian rivals.

"There are two great and undoubted factors which tend to ensure such a development of British Overseas trade to a very considerable extent. One is to be found in the safety of the trade routes, together with the protection afforded by the State scheme of insurance against war risks, and the financial measures also taken by the Government for the continuance of business transactions. The second is that German and Austro-Hungarian trade with foreign countries is at a standstill.

"In pursuance of this scheme the Commercial Intelligence Branch of the Board of Trade (73 Basinghall Street, E.C.) are issuing to manufacturers and merchants, trade associations and chambers of commerce, monographs giving information with regard to possible foreign and Colonial developments in certain important trades carried on by them or in their respective districts. The trades dealt with in the first series of monographs are cutlery, iron and steel wire, hollow-ware (enamelled or tinned), woollen and worsted piece goods, and cotton hosiery (stockings and socks)."

To those who have followed the German "culture" for the last thirty or forty years it is well known that the fostering of their industries in that country by technical instruction in all forms has been increasing, and it will be found that our manufacturers will have the greatest difficulty in carrying out the Government's intention precisely in those branches of industry in which technical instruction of the most advanced kind, with accompanying research, has been most lacking in Britain.

For some time before the war a committee of the British Science Guild was preparing a statement showing the disadvantages under which the optical trades suffer in this country, and we are glad to see that the President of the Board of Trade has now appointed a committee "to consider and advise as to the best means of obtaining for the use of British industry sufficient supplies of chemical products, colours, and dye-stuffs of kinds hitherto largely imported from countries with which we are at present at war." Of this Committee Lord Haldane is chairman, and Dr. Beilby and Profs. Meldola and Perkin are among the members.

Let us hope that these and other similar efforts will be fruitful of result. Let us increase our "culture," not as part of a settled plan for the detriment of other countries, but as a serious endeavour to advance our own Empire and modern civilisation generally with all that it brings with it.

BIOLOGY OF THE SEX- AND BLOOD-CELLS.

(1) *Artificial Parthenogenesis and Fertilisation.* By Jacques Loeb. Originally translated from the German by W. O. Redman King. Supplemented and revised by the Author. Pp. x+306. (Chicago: University of Chicago Press; London: Cambridge University Press, n.d.) Price 10*s*. net.

(2) *The Biology of the Blood-cells. With a Glossary of Haematological Terms.* By Dr. O. C. Gruner. Pp. xii+392+plates. (Bristol: John Wright and Sons, Ltd., 1913.) Price 21*s*. net.

(1) THE development of the female cell or egg without fertilisation by the male cell or sperm—parthenogenesis—has been known to occur among the plant lice, or aphides, since the eighteenth century, but the artificial production of a similar phenomenon—artificial parthenogenesis—is essentially an accomplishment of the closing decades of the nineteenth century. This book gives an excellent and fascinating summary of the considerable amount of experimental work which has now been performed on this subject. Artificial parthenogenesis has been principally carried out with the eggs of sea-urchins, but the same kind of results have also been obtained with those of starfish, annelid worms and molluscs, and also with frogs and toads. Although there is usually considerable mortality among the artificially fertilised forms during the earlier periods of development, Delage has reared two parthenogenetic larvæ of the sea-urchin during sixteen months to a stage of sexual maturity, and Loeb and Bancroft raised tadpoles, and even a young frog with eggs in the sex-glands, from artificially fertilised frogs' eggs!

Commencing with some general remarks on the morphology of development, the influences of oxidation and of membrane formation on the development of the fertilised egg are considered. Apparently oxygen is necessary for development, and all observations point to the conclusion that the processes determining or underlying nuclear division depend upon oxidation. While a certain amount of oxidation proceeds in the unfertilised egg (and ultimately leads to its disintegration and death), the essential effect of the entrance of the sperm seems to be an acceleration, it may be to six-fold, of the oxidation processes, and if fertilised eggs be deprived of all oxygen no nuclear or cell division occurs; other reactions, such as hydrolyses, also doubtless take place. Another result of fertilisation is the immediate formation of a membrane, the fertilisation membrane, which surrounds the egg, after which the chemical processes that underlie development ensue.

The earlier successful attempts to induce artificially the development of sea-urchin eggs were obtained by the use of hypertonic sea-wate (100 c.c. sea water + 2 grams sodium chloride). The eggs are first soaked in the hypertonic solution for 2–4 hours, and are then returned to ordinary sea-water; if allowed to remain in th hypertonic solution no development takes place. Other hypertonic solutions, provided they possess a similar osmotic action and are not poisonous (as is the case, for instance, with copper salts), may also be used. Better methods have since been devised, *e.g.* treatment first with a fatty acid, such as butyric, then with sea-water, next with the hypertonic solution and finally removal to sea-water. The fatty acid initiates membrane formation, the hypertonic solution the oxidation processes. Various substances, such as saponin, which have a lytic or solvent action upon the cortical layer of the egg and therefore lead to membrane formation, can also be substituted for fatty acid.

Another fact of considerable interest is that blood or tissue-extracts, or the dead or living sperm, of a *foreign* species will induce membrane formation in the unfertilised sea-urchin egg, while the extracts of the sea-urchin itself are inefficient to do so and the *living* sperm is alone effectual. This appears to be due to the fact that the foreign materials can diffuse into the egg, while its own materials are unable to, but must be carried by the *living* sperm. Various questions connected with heredity are discussed, and finally a chapter deals with the interesting question—can an embryo develop from a sperm? Apparently in yolk and white of egg, fowl sperm can undergo transformation into a nucleus, but we are not yet in a position to state that the sperm can undergo mitosis outside the egg. Altogether this book can be recommended as an authoritative statement on artificial parthenogenesis by one who has himself contributed so much to the subject.

(2) Comparatively simple as the structure of the blood seems at first sight to be, the more it is studied the more complex it becomes, and the literature dealing with this subject has now become truly enormous. In the present volume the author has attempted to summarise the researches that have been carried out on the structure, functions, and origin of the various elements of the blood, both normal and abnormal, which make their appearance in cases of disease. On the whole we think the author has accomplished his object, and has produced a reference book which will be very useful to those who are working at this subject. A bibliography, a glossary of hæmatological terms (which runs into more than thirty pages), and indexes to subjects and to authors, complete a work which must have entailed a considerable amount of labour.

R. T. H.

MATHEMATICAL TEXT-BOOKS.

(1) (*a*) *Plane and Solid Geometry.* By Prof. W. B. Ford and C. Ammerman. Edited by E. R. Hedrick. Pp. ix + 321 + xxxiii. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1913.) Price 5*s.* 6*d.* net.

(*b*) *Solid Geometry.* By Prof. W. B. Ford and C. Ammerman. Edited by E. R. Hedrick. Pp. ix + 215–321 + xlix. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1913.) Price 3*s.* 6*d.* net.

(2) *A School Course in Geometry.* By W. J. Dobbs. Pp. xxii + 427. (London: Longmans, Green and Co., 1913.) Price 3*s.* 6*d.*

(3) *Analytic Geometry and Principles of Algebra.* By Prof. A. Ziwet and L. A. Hopkins. Pp. viii + 369. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1913.) Price 7*s.* net.

(4) *Slide-Rule Notes.* By Colonel H. C. Dunlop and C. S. Jackson. Pp. 127. (London: Longmans, Green and Co., 1913.) Price 2*s.* 6*d.* net.

(5) *A First Numerical Trigonometry.* By W. G. Borchardt and the Rev. A. D. Perrott. Pp. xi + 159 + xvii + xvii. (London: G. Bell and Sons, Ltd., 1913.) Price 2*s.* 6*d.*

(6) *Elementary Graphic Statics.* By J. T. Wight. Pp. xii + 227. (London: Whittaker and Co., 1913.) Price 4*s.* net.

(7) *Models to Illustrate the Foundations of Mathematics.* By C. Elliott. Pp. viii + 116. (Edinburgh: Lindsay and Co., 1914.) Price 2*s.* 6*d.* net.

(8) *Exercises in Mathematics.* By D. B. Mair. Pp. xi + 469. (London: Macmillan and Co., Ltd., 1914.) Price 4*s.* 6*d.*

(9) *A School Statics.* By G. W. Brewster and C. J. L. Wagstaff. Pp. viii + 248. (Cambridge: Heffer and Sons, Ltd., 1913.) Price 3*s.* net.

(10) *Proceedings of the London Mathematical Society.* Second series. Vol. xii. Pp. lix + 488. (London: Francis Hodgson, 1913.)

(1) IN America, as in England, the teaching of geometry has altered recently both in method and scope; and these changes are indicated in the report of the committee of the National Education Association, the recommendations of which have been in the main adopted by the authors of this volume. The limitations of the subject-matter are similar to those with which English students are familiar, but there is a marked difference in the arrangement. The treatment of areas is postponed nearly to the end of the course, thus enabling angle and

tangent properties of the circle and theorems in proportion and similarity, to be taken at an early stage.

The course of solid geometry, which occupies about one-third of the volume, and can also be obtained separately, follows the usual lines. There are three sections: (1) lines and planes in space; (2) polyhedra, cylinders, cones; (3) the sphere, the latter being treated more fully than usual. The examples are less conventional and more interesting than those in the ordinary text-book.

(2) The author holds very strongly that pure geometry should not be separated from other branches of mathematics. In a single volume he has included quite a considerable amount of trigonometry, calculus, and analytical methods (solid geometry is reserved for a second volume); and he has attempted to shew how all these subjects should be combined together, each assisting the development of the other. If proofs of geometrical properties can be simplified by the use either of trigonometry or analysis, he maintains that not only is it legitimate to do so, but that it is definitely wrong to ignore this opportunity. Mr. Dobbs's book should exercise a refreshing influence on educational methods.

(3) Into the ordinary analytical course a certain number of sections on pure algebra have been introduced on the ground that their utility can best be explained in this connection. This certainly justifies the inclusion of simultaneous equations, theory of equations, complex numbers, gradients, and determinants; the brief account, however, of permutations and combinations in connection with the latter seems somewhat irrelevant. The examples are of a numerical character, and advanced geometry of the conic is left aside. Special mention must be made of an interesting section on higher plane curves and empirical equations. The last four chapters cover the usual course of solid geometry so far as quadrics referred to principal axes.

(4) Mr. Jackson's name is in itself a sufficient guarantee that students will find all that they can possibly require in this account of the use of the slide-rule. After a brief introduction there are successive chapters on proportion, evolution and involution, the solution of quadratic and cubic equations, the trigonometric and logologarithmic scales, the plotting of curves and errors. The reader must of course have a slide-rule in his hand, but the clearness of the diagrams from which all superfluous markings have been omitted will make his task easy.

(5) This book is designed for the junior forms of secondary schools, in view of the fact that trigonometry is now given an early place in the curriculum. The examples are therefore of a simple character; radian measure is postponed to the last chapter, and identities and compound angles are excluded. We think that an unnecessary amount of space has been devoted to logarithms; all modern text-books on arithmetic and algebra contain chapters on this subject, and its repetition here is a survival from the times when only seven-figure tables were used. There is a first-rate set of test-papers at the end of the book.

(6) This is a book for the practical engineer, but it contains many problems that might usefully be set to the mathematical specialist. No previous knowledge of mechanics and only the elements of algebra are required. After a clear discussion of resolution and composition, the triangle of forces and Bow's notation, various problems of the crane are considered. The graphical theory of moments, bending moments, and shearing forces is then described, and applications are made to dead and rolling loads, symmetrical and unsymmetrical roof loadings, wind pressure, walls withstanding pressure, centre of gravity and moments of inertia. The author has succeeded in compressing into a comparatively small compass a great deal of valuable matter. There is, of course, naturally nothing that is original, but the contents are just what the ordinary engineering student most needs.

(7) The purpose of this tract is to advocate the introduction of some account of modern views upon the foundations of mathematics into elementary work. It is claimed that by a judicious use of models an insight can be gained fairly easily into the root ideas of mathematical philosophy, and that by a method which involves only an extension or rearrangement of the practical work now being done at school. The ideas here dealt with are correspondence, class, classification, multiplexes, etc. We cannot think this is suitable for the ordinary boy: however simple the illustrations may be, he will almost certainly fail to carry away with him anything he can himself regard—and that is in itself of very great importance—as real knowledge.

(8) Every teacher should possess this book; the exercises cover the course of arithmetic, algebra, geometry, and trigonometry taken by the non-specialist, and may be used either for revision or to supplement at a first reading the ordinary text-book. Some of the sections are headed by a note recommending their omission if not required for examination purposes. Apart from these, the questions are so chosen as to test the intelligence of the student, to illustrate the utility of the

subject, and exhibit its practical bearing. It is the best collection of mathematical examples we have yet met.

(9) Now that an experimental course of statics has obtained a firm foothold in the school curriculum, it is possible to introduce boys of no special mathematical talent to certain features of theoretical work. In addition to the elements of geometry and algebra, nothing more than a knowledge of the trigonometry of the right-angled triangle is needed for applications of all the fundamental ideas which make this subject educationally valuable.

The volume before us contains just what is needed for work of this character. It opens with the use of pulleys and the ideas of work, power, velocity-ratio, and efficiency. Then follow simple cases of moments and applications to the more important machines. In this way the student is led at once to see the practical utility of the work, and is able by experiment to clarify his conception of force, etc. No use is made of the parallelogram and triangle of forces until comparatively late in the course, and formal bookwork proofs are postponed to the end. The examples are chosen so as to illustrate the principles of mechanics rather than to test the student's analytical ability.

(10) We are glad of this opportunity of directing attention to the work that is being done by the London Mathematical Society. All those who are interested in any branch of higher mathematics, whether they hope or intend to do any research work or not, should apply for election. Only in this way is it possible for students to keep in touch with the trend of modern developments when their University days are over.

OUR BOOKSHELF.

British Rainfall, 1913. Compiled under the direction of H. R. Mill. By R. C. Mossman and C. Salter. Fifty-third annual volume. Pp. 92+384. (London: E. Stanford, Ltd., 1914.) Price 10*s*.

THIS valuable publication is well known to readers of NATURE, having been frequently referred to in its columns. The fundamental part of the work includes: (1) general tables of total rainfall, and (2) observers' remarks on the weather; these are of great interest, and refer mostly to exceptional phenomena. The discussion of the data deals *inter alia* with monthly and seasonal rainfall, heavy daily falls, and the relation of the annual rainfall to the average. A great rainstorm of September 17, which was most intense near Doncaster, is illustrated by a coloured plate; the area with more than an inch of rain in about fourteen hours comprised more than 1300 square miles. The rainfall of the year over the whole of the British Isles was almost exactly equal to the average of thirty-five years (1875–1909). The excess in Wales was 9 per cent. and in Ireland 7 per cent.; elsewhere there was, generally speaking, a deficiency. The volume includes three special articles: (1) an appreciative memoir of the late Sir John Murray, who represented Scotland on the Board of Trustees of the British Rainfall Organisation; (2) the dry summer of 1913—in July and August the rainfall deficiency was 60 per cent. over the United Kingdom as a whole; (3) frequency of heavy rains in short periods, 1868–1913. The useful work of the organisation is dependent upon voluntary contributions, but unfortunately it is not self-supporting; the director has to meet considerable deficiencies, consequently application for Government aid has become necessary.

Handbook of Photomicrography. By H. Lloyd Hind and W. Brough Randles. Pp. xii+292+44 plates. (London: George Routledge and Sons, Ltd., n.d.) Price 7*s*. 6*d*. net.

THIS book gives a useful and adequate account of the theory and practice of photomicrography. It is written from the point of view of the beginner and amateur, and full explanations are given of the principles governing the results aimed at and of the methods for obtaining these results. Photomicrography with the lowest and highest powers is dealt with, and wherever possible simple and home-made apparatus is described. In addition to photomicrography proper, the various photographic processes are explained and described, and methods of making lantern slides, colour photography, and the preparation and mounting of objects are included. The book is well produced and profusely illustrated both by figures in the text and with forty-four plates, several of which are coloured and reproduced from direct colour photographs. The plates illustrate very well the different results that can be obtained with different methods of illumination, various objectives and varying adjustments. We believe that Messrs. Hind and Randle's handbook will be found a very useful work on the subject of photomicrography.

The Microscopy of Drinking Water. By Prof. G. C. Whipple. Third edition, rewritten and enlarged. Pp xxi+409+xix coloured plates. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 17*s*. net.

WE are glad to welcome the third edition of this valuable book. Since the first edition was issued in 1880 an enormous amount of work has been devoted to the study of the microscopic organisms in water, and the increase in size of the present edition bears witness to this. The mystery of the comings and goings of various groups of algæ and protozoa in our lakes and reservoirs still, however, remains unsolved. From the practical side much progress has been made in the artificial means of controlling Plankton growths and the purification of waters containing them.

The first part of the book has been almost rewritten, and contains chapters on copper treatment for eradication of algæ, the soil-stripping of reservoir sites and the use of the microscope and photomicrography. The latter portion of the book, containing descriptions of various groups of water-organisms, has also been revised, and the plates showing the commoner organisms of water have been printed in colours, making identification easier.

The book is one which should find a place in every bacteriological and public health laboratory and in the office of the water-engineer.

R. T. HEWLETT.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Micromillimetres and Micromicrons.

IT is very desirable that men of science should adhere to the conventions which have been established with regard to the use of the terms employed for units in the metric system. It has been generally agreed that the prefixes mega- and micro- should indicate the multiplication and division respectively by a million of the unit expressed by the term they precede. In this way a micrometre usually shortened to *micron*, means a millionth part of a metre, or, in other words, a thousandth of a millimetre; and a *micromillimetre* signifies a millionth part of a millimetre, or, what is the same thing, a thousandth part of a micron. It is, therefore, to be regretted that in the translation, published in Geneva, by L. Duparc and Vera de Dervies, of Nikitin's excellent account of Fedorov's "universal" method of microscopical mineral research we find the term *micromicron* employed in place of micromillimetre. The former term should mean a millionth part of a micron—that is to say, a metre $\times 10^{-12}$, a unit that might be usefully employed in expressing intermolecular or interatomic distances in crystals, which we are now at last in a position to determine in many cases.

JOHN W. EVANS.

Imperial College of Science, South Kensington,
September 3.

Origin of Species.

IN Darwin's great work on this subject he claims that Dean Herbert, in 1822 and 1837, held that "single species of each genus were created in an originally highly plastic condition, and that these have produced, chiefly by intercrossing, but likewise by variation, all our existing species."

Years of study along this line have assured me that he was right. I am now especially interested as I have a few trees on hand which seem to prove this position. They are a cross between Quercus and Juglans, which bears walnut-like nuts on a tree which bears oak-like leaves: at least a new species and perhaps a new genus. If this tree had been found in the forest it would have caused no remarks, but originating in the garden it has become the wonder of the world. Here is an oak tree in appearance which bears perfect walnuts, all originated in one year and fairly productive and fixed.

This tree gives me further evidence of the fact that all sexual life known to us, both animal and vegetable, has sprung from hybrids.

NEWTON B. PIERCE.

Pacific Coast Laboratory and Wild Plant Improvement Gardens, Santa Ana, California.

LECTURES ON THE ANIMAL KINGDOM BY LINNÆUS.[1]

IT is probable that most modern zoologists, when unfamiliar with the Scandinavian tongues, know little of the zoological writings of Linnæus beyond the "Systema Naturæ," and that from this restricted evidence they draw the natural but entirely erroneous conclusion that, considered as a zoologist, Linnæus was little more than a methodical compiler, classifier, and name-giver. If, moreover, the modern zoologist is not so well acquainted with the history of his science as he should be, he is apt to seize rather on the defects, or even absurdities, in the "Systema" as compared with his own knowledge, and to ignore the real advances made by the great Swede over the attempts of his predecessors. There are, as we have hinted, many writings by Linnæus that prove the falsity of such opinions, and now another has just been issued by the University of Uppsala which enables one to read between the lines of the "Systema," and to realise the wide zoological knowledge and still more the philosophy and humanity on which it is based. The volume consists of a complete course of lectures on the animal kingdom, delivered by Linnæus between 1748 and 1752, and collected from the notes made by various pupils, of which more than forty manuscripts are preserved in the university library. The collation of these manuscripts was begun by the late Dr. M. B. Swederus, and has been completed by Dr. Einar Lönnberg, with the help of Miss Greta Ekelöf. The lectures are followed by a detailed commentary and by short accounts of 123 authors quoted by Linnæus; these two parts are by Dr. Lönnberg, who has availed himself of the help of various colleagues, living and dead.

And now of Linnæus as a lecturer, what may we think? Approaching him at second-hand, and without the magic of his enthusiastic presence, we yet see how he infused a living and practical interest into what might so easily have been a dry catalogue of species. An undergraduate's notebook omits much that the writer does not consider essential, the humorous asides, the occasional divagations, the purple patches; but the students of Uppsala realised that they listened to no ordinary man, and it is clear that much has been taken down verbatim. Certainly, that must be the case with the stately Prolegomena, which we should like to have translated in full, but must at least make some attempt to abstract:—

Generation after generation of earthly creatures comes into being only to pass into nothingness. And yet, though fashioned only for vanity, each creature struggles to preserve its life; one preys upon another so that nature is a *bellum omnium perpetuum in omnes*, and of all creatures man is most inhuman. And yet man, with his works of wisdom, his castles and towers, comes only to dust. What is the object of so vain a contrivance? The answer is given by natural history.

[1] Linnés Föreläsningar öfver Djurriket, med understöd af Svenska Staten för Uppsala Universitet utgifna och försedda med förklarande anmarkningar af Einar Lönnberg. (Uppsala, 1913.)

Particles of stone build up the mountains, and these, again, break down into stones and sand. But on this live the plants, each springing from a tiny seed, and growing from mould, with a little water and air, to such a wonder-work as all the artists of the world cannot rival. They bloom and seed and perish, but meanwhile they shelter and give food to all kinds of animals. And the animals, they too spring each from a little seed; and earth, air, and water are compounded to form that masterpiece which every animal is. Yet the animals feed, not on mould, but on the plants; and all animals in their turn serve the needs, the nourishment, or the pleasure of mankind. And so comes the conclusion: all is fashioned for the sake of man. Earth, herb, beast, and man; further the metamorphosis cannot go. But why is this great world created for man? Is not he, too, a thing of naught? What mighty attributes has he? This, this is his peculiar property: that not only can he see, hear, smell, taste, feel things, but that he can also contemplate the marvellous construction of all natural bodies, fathom their peculiar qualities, and reason therefrom to their high and skilful Master.

Love of life forces every creature to seek the necessaries of life. Man goes out with the rest, and so he must note and admire the work of the Creator. Some rich men, indeed, with all needs ready supplied, are little better than savages who sit in the sun and let fruit drop into their mouths; but the poor, who must earn food with toil and sweat, learn better to thank God therefor.

The true inquirer into nature's works must observe with accurate attention, seek out origins, follow generation and growth, unravel use and harm, and finally note change and decay. He looks not on the rowan-berry with the eyes of the raven, tastes not the herbs with the tongue of an ox, nor sports with doves after the manner of the hawk. Not hastily, not upon one or even upon many journeys, but ceaselessly and diligently must the inquirer mark and ponder on the natures and causes of things, on their relations both to themselves and to their surroundings, seeing that no natural thing lives or dies to itself alone.

Some object that natural history is but a heap of useless names. True, to know a heap of names and nothing more is no learning. But it were as easy to become a scholar without the alphabet, as a naturalist without names. Describe me a thing precisely as you will, I can make no use of it without a name; only by names can such knowledge be passed on, since the object cannot always accompany the description. Names are the alphabet of natural knowledge; and that is a true science, one that should be taught in all schools for the sake of its practical service to our country. . . .

Throughout the course the points here emphasised find abundant illustration, and often throw a curious light on the customs, the rural economy, the medicine, and the philosophy of the day. It would have been easy to pick out some delicious plums, but it seemed better to give, so far as might be in the words of Linnæus himself, the principles that guided him, and may still inspire us, in the illimitable study of nature.

F. A. B.

NOTES.

A GIFT of 20,000*l*. has been promised to London Hospital by Mrs. E. S. Paterson for cardiac research work.

ONCE again the Arctic claims its toll. The *Times* correspondent at Petrograd (St. Petersburg) reports that Lieut. Sedoff, the leader of a Russian attempt on the north pole, was taken ill at Hooker Island, Franz Josef Land, in September, 1913. The party was in dire straits in winter quarters, as the coal was all burnt and even parts of the ship were used for fuel. During February, 1914, a dash was made polewards; but, in March, Lieut. Sedoff, who had not recovered from his illness, died between Franz Josef Land and Rudolf Island. He had set out accompanied by two sailors and twenty-four dogs. The sailors buried the body, abandoned the dogs, and returned. The *Foka*, Sedoff's ship, had previously, in August, 1913, been useful in the rescue of two members of the Brousiloff Expedition. M. Brousiloff, with half the expedition, is reported still in his ship, the *St. Anna*, hoping that the current will carry the ship north of Spitsbergen, so that he can break through southwards. In consequence of the privations they had endured on the voyage from the Kara Sea, eleven members of the expedition left the ship; of these all perished but the two rescued by the *Foka*.

THE Board of Agriculture and Fisheries has received the following from the Agricultural Consultative Committee :—Milk-sellers or others who have a surplus of milk to dispose of are strongly urged to take steps to have it converted into cheese either in their own dairies or cooperatively. This method of dealing with surplus milk beyond what is required for immediate consumption will not only be found more remunerative than separating the milk and making the cream into butter, but will also be a useful means of contributing to the conservation of the food supply of the nation. The types of cheeses most suitable for manufacture in the circumstances are Cheddar, Cheshire, Derby, Leicester, and Gloucester, or such other varieties as do not deteriorate under reasonably prolonged storage.

IN the medical papers and in the *Times* the value of, and necessity for, anti-typhoid vaccination for all branches of the Army have been urged by Sir William Osler, Sir Lauder Brunton, and Sir William Leishman. Figures quoted by Sir William Leishman are eloquent as to the efficiency of the vaccination for the prevention of typhoid fever: in India, where formerly this disease among the British garrison cost us from 300–600 deaths annually, was last year responsible for fewer than twenty deaths, 93 per cent. of the men now being inoculated. Large supplies of the vaccine have been prepared at the Royal Army Medical College, while the department for therapeutic inoculation, St. Mary's Hospital, Paddington, has furnished nearly

280,000 doses of the vaccine for the use of the Army. Sir Almroth Wright, the author of anti-typhoid inoculation, points out in the *Times* that it is already compulsory in the French and American Armies, and he urges that it should now be made so also in the British Army. He states also that 180,000 doses of an "anti-sepsis" vaccine have been supplied to our Army and Navy, and also to the French military hospitals during the past three weeks. It is believed that this vaccine will be of great value in protecting our Army from bacterial infection of wounds.

A SUMMARY of the weather for the past summer as comprised in the thirteen weeks ending August 29 has been given by the Meteorological Office for all districts of the United Kingdom. The mean temperature for the summer is above the average in all parts of the British Isles. The excess is greatest in the north of Scotland and in the north and north-east of England, where it amounts to about 1·5°, and in the east and west of Scotland, the midland counties, and the north-west of England the excess is 1°. In the Channel Islands the excess of temperature is very trifling. The south-east of England is the only district in which the highest temperature has reached 90°. The aggregate rainfall for the summer varies considerably in different districts of the United Kingdom. The highest excess of the summer fall is 125 per cent. of the average in the south-west of England, in the north-east of England, and in the midland counties the fall is 112 per cent. of the average, and the Channel Islands is the only other district with an excess, with 107 per cent. of the average. In the north of Scotland the rainfall is only 71 per cent. of the average, and 78 per cent. in the west of Scotland and in the east of England. In the south-east of England the summer fall is 88 per cent. of the average. The duration of bright sunshine is generally in excess of the average.

PROF. O. SCHLAGINHAUFEN reviews the pygmy question in New Guinea in the *Festschrift der Dozenten der Universität Zürich,* 1914, and in Melanesia in the *Arch. Suisses d'Anthrop., Geneva.* 1914. He comes to the conclusion that in Melanesia we know of only one group which can be called pure pygmy, the Tapiro of West Netherlands, New Guinea, with a mean stature of 144·9 cm., described by Wollaston and Rawling. Then come four tribes, the Kamaweka of the Mekeo district, British New Guinea, noted by Seligmann, the Goliath group of Netherlands New Guinea, described by van den Broek, the Torricelli group, and Kai of German New Guinea, described by himself and Pöch respectively, all with a mean somewhere about 150 cm. These are often regarded as a mixture between true pygmies and tall varieties, but there is no proof of this. These five tribes inhabit the hilly interior. For all groups studied in New Guinea the general rule holds good that stature increases from inland to the coast, and the cephalic index (with some exceptions) decreases. The author holds that this association points to these being less racial characters than functions of geographical control. Dolichocephalism combined with low stature has not yet been observed in New Guinea or the Bismarck Archipelago. No distinct group of pygmies have been found as yet in the Bismarck Archipelago or the Solomon Islands, though very short people occur sporadically. The author gives an interesting coloured map showing the distributions of stature in New Guinea and the Bismarck Archipelago.

AN illustrated account of a sixteenth-century building at West Hoathly, Sussex, known as the Priest House, which has been restored and fitted up as a museum by Mr. Godwin King, appears in the *Museums Journal* for September. Admirable as is the restoration, it would have been better if the interior had been refitted according to the original plan. This, it is suggested, may, however, be indicated in a miniature model of the building.

IN his presidential address at the annual meeting of the new Zealand Institute (Proc., vol. xlvi.), Dr. C. Chilton paid a well-deserved tribute to the services rendered by the late Augustus Hamilton to that body, and also to the Dominion Museum, of which he was director. In a later part of the address the president directed attention to the unsatisfactory housing of the valuable specimens and the library of the Institute in the Dominion Museum. The majority of the specimens in portions of the collection—especially the examples of Maori workmanship and art—are irreplaceable, "yet they are still housed in a wooden building that is almost falling to pieces through age, and the greater part of which has been declared to be insanitary for human beings."

IN vol. iii., part 3, of Records of the W. Australian Museum, Mr. L. Glauert gives an account of new discoveries of mammalian remains in the so-called mammoth cave. The most interesting of these pertain to a big echidna, believed to have been double the size of the living Australian *Echidna aculeata*, and also exceeding in size any of the previously described extinct forms, one of which has been referred to the genus Zaglossus, or Proechidna, now confined to New Guinea. The new specimens are, however, considered to represent a still larger species, for which the name *Zaglossus hacketti* is proposed. In recording remains of the Tasmanian wolf and Tasmanian devil from the same cavern, Mr. Glauert incidentally mentions that an apparently wild individual of the latter species was killed near Melbourne in 1912.

IN an admirably thought-out article on the osteology of Permian reptiles, in No. 8 of vol. i. of Contributions from Walker Museum, published in this country by the Cambridge University Press, as agents for the University of Chicago Press, Mr. S. W. Williston gives certain very cogent reasons for deposing the New Zealand tuatera (Sphenodon) from its hitherto undisputed position as one of the most primitive reptiles with which we are acquainted. As the result of an elaborate study of the skeleton of the lizard-like Aræoscelis from the Permian of Texas, the author has come to the conclusion that in the earliest reptiles it is much more probable that the bony skull-roof inherited from the stegocephalian amphibians should have been perforated only once, rather than twice, on each side, and consequently that the two bony temporal arcades of the tuatera represent a more specialised type than does the single one of lizards. And when once the matter is put before us in this straightforward manner, we can scarcely refrain from wondering why we never thought of it before. Aræoscelis, in which there is certainly but a single arcade, is regarded by the author as the typical representative of a group—Aræoscelidia—which shall include the European Permian genera, Protorosaurus and Kadaliosaurus, and the position of which should be next the Squamata (lizards and snakes). Ichthyosaurs, which never possessed a lower temporal vacuity, and are evidently a primitive group, are not improbably more or less nearly related to the Aræoscelida. Palæohatteria, on the other hand, which has long been associated with the European representatives of the last-named group, is in every essential character near akin to the Pelycosauria, in which it should typify a special family.

MR. JAMES RITCHIE, of the Royal Scottish Museum, has published a short but interesting paper on the fauna of a deep coal-pit in Midlothian. None of the animals show any indication of bleaching or blindness, and it is evident that all must have been artificially introduced, to a great extent, with the timber used as props. The only springtail in the list is *Tomocerus minor,* a species that happens to be constantly found in caves, but none of the characteristic white, blind cave-insects of the order Collembola were discovered in the coal-pit.

THE valuable series of "L.M.B.C. Memoirs" published by the Liverpool Marine Biology Committee has reached No. xxii., in which Mr. Herbert C. Chadwick, of the Port Erin station, describes the Echinoderm larvæ taken by tow-netting in the neighbouring waters. Most of the larvæ described are ophiuroid or echinoid plutei, the young stages of asteroids and holothuroids being unexpectedly scarce. The memoir is illustrated with nine plates of excellent structural figures.

DR. G. K. GILBERT, with the aid of Mr. E. C. Murphy, has made a characteristically thoughtful study of "The Transportation of Débris by Running Water" (U.S. Geol. Survey, Professional Paper 86, 1914). Working with an experimental trough some 30 ft. in length, which could be adjusted at various slopes, and another trough, 150 ft. in length, which was kept horizontal, measurements were made of the quantity of material of known grade carried forward by traction on a bed built up of similar grains and moulded by the flow. Such a bed represents the conditions that occur in nature, and "the material of the load is derived from and returned to the bed," in contrast with movement in "flume transportation," where the artificial channel has a rigid floor. "Saltation," where a particle is caught in an ascending swirl and shot forward for a time freely above the bed, plays an important part in transportation; and a particle "in suspension" may be regarded as making a very long leap of this kind. The present work, which does full justice to the complex phenomena, is concerned with traction and not with suspension.

DETAILS of severe shocks in the earthquake belt extending from Sumatra to New Guinea and the Carolines are published (in Japanese) in the Journal of the Meteorological Society of Japan for July, 1914. Two such earthquakes have occurred so far this year, details of which were recorded at the Osaka Seismological Observatory as follows:—(1) April 12, at 1h. 39m. 41s. a.m.; preliminary tremor lasting 7m. 22s., principal shock, 6m. 0s.; maximum amplitude, E.–W. movement at 1h. 57m. 5s., 632 microns, period 20·2s.; S.–N. movement at 1h. 58m. 1s., 747 microns, period 21·6s.; total duration of shock, E.–W. 2h. 11m., S.–N. 2h. 14m.; located near Gilbert Island, east of New Guinea. (2) May 26, at 11h. 29m. 56s. p.m.; preliminary tremor lasting 5m. 53s., principal shock, 3m. 4s.; maximum amplitude, E.–W. movement at 11h. 47m. 8s., 2187 microns, period 23·0s.; S.–N. movement at 11h. 50m. 41s., 4305 microns, period 20·8s.; total duration of shock, E.–W., 3h. 29m., S.–N., 3h. 33m.; located near Celebes. Nine earthquakes of a similar or greater magnitude than the latter, it is noted, have occurred in the same region since 1907, the intervals separating them showing a gradual diminution in length.

IN the last report of the Meteorological Committee mention was made of the increase in the sale of the *Daily Weather Report,* which is due largely to subscriptions from schools; for some years past back copies have been supplied for educational purposes at the cost of postage. A notable case of the use that may be made of these charts and other Meteorological Office publications is explained by Mr. W. E. Whitehouse, assistant lecturer in physical geography at Aberystwyth University College, in a pamphlet entitled "Suggestions for a Course in Climatology in Correlation with Geography," by means of which "a vital section" of the latter can be more systematically treated. The large number of questions for pupils cover most of the ground included under modern meteorology, and a student who could satisfactorily reply to the majority of them might claim to be well equipped in meteorological science. A useful bibliography has also been prepared in graded sections for the use of teachers and others. The pamphlet is prefaced by a very interesting introduction by Dr. Shaw; while fully recognising the practical and educational utility of the suggestions, he thinks (as we do) that the author is "very liberal in his interpretation of the scope of the science of climatology."

IN connection with the Canadian National Exhibition which has been opened at Toronto, the Imperial Department of Agriculture for the West Indies has issued an illustrated handbook under the title, "The West Indies in Canada," showing the main features of the industrial and trade relations of the West Indies, the nature of recent agricultural developments, and a description of the principal products of the islands. From this handbook it appears that Citrus planting is being rapidly extended in British Guiana and St. Lucia, tea is being planted in Jamaica, and cigars are now exported from Jamaica in considerable quantity. An interesting minor product is papaw, a pleasant table fruit derived from *Carica papaya*, which is grown in Montserrat, and serves as a source of papain, a digestive ferment the demand for which is rapidly growing, especially in Canada, and the United States. The cultivation of rice is also being greatly developed in Trinidad and British Guiana.

IN the April number of the *Astrophysical Journal* Dr. Wali-Mohammad, of Aligarh College, India, described the results of his investigation of the degree of complexity of the spectral lines of aluminium, bismuth, cadmium, chromium, cobalt, copper, lead, magnesium, manganese, silver, sodium, tin and tellurium. As source of light he used a Wehnelt tube in which the kathode consisted of a platinum foil covered with oxides of barium and calcium, and the anode of the metal to be investigated contained in a porcelain tube. A potential difference of 200 volts was maintained between the anode and the red hot kathode. The tube was water-cooled and the pressure within it less than 0·01 mm. of mercury. The light passed out of the tube through a glass window at the top and was received by a Hilger echelon grating of 35 plates. The spectra were photographed on a series of plates each suitable for a part of the spectrum. The author found that few of the metals possessed complex lines, and of those that did copper, lead, and manganese had lines of similar structure. In nearly all cases the structure shown by the echelon agreed with that found previously by crossed Lummer plates.

IN the domain of electro-chemistry the greatest commercial developments recently have been in the utilisation of nitrogen from the atmosphere for the manufacture of nitrogen products. It is only since electrical power has been obtainable in large amount at exceptionally low cost that the operations have been carried out profitably on a commercial basis. Probably the most interesting of the processes for the fixation of atmospheric nitrogen is that in which calcium carbide is employed as the medium for the production of calcium cyanamide. We learn from *Engineering* for August 28 that the Odda works in Norway are now producing 85,000 tons of calcium carbide and 80,000 tons of calcium cyanamide per annum, a result due largely to the admirable mechanical appliances in use. The electric power available at Odda will soon be increased to 125,000 horse-power, and the carbide and cyanamide factories will be further enlarged. The Nitrogen Products and Carbide Company have acquired water-fall rights in Norway and Iceland which will enable a total of about one million horse-power to be generated—sufficient for the production of nearly two million tons of cyanamide per annum. It may be noted that the use of cyanamide as a fertiliser is increasing rapidly.

THE Carnegie Institution of Washington has published the second volume of the "Guide to the Materials for American History, to 1783, in the Public Record Office of Great Britain." This part contains departmental and miscellaneous papers, and is by Prof. C. M. Andrews, Farnam professor of American history in Yale University. The scope of the work and the method of treatment were explained when attention was directed to the publication of the first volume. The new part runs to 427 pages, and deals with papers of the Admiralty, the Lord Chamberlain, Custom House, Treasury, War Office, High Court of Admiralty, and other departments.

OUR ASTRONOMICAL COLUMN.

COMET 1913*f* (DELAVAN).—The following short ephemeris gives the positions of Delavan's comet (1913*f*) for the current month:—

Greenwich Midnight.

	R. A. h. m. s.	Dec. ° ′
September 8 ...	9 8 35 ...	+49 56
16 ...	10 8 6 ...	49 51
24 ...	11 9 33 ...	47 56

The comet is now in the constellation of Ursa Major, and is not far from the two third magnitude stars κ and ι. On clear nights it is a conspicuous object in the northern heavens, and is easily picked up from the rough chart given in this column for last week. It is gradually becoming brighter, but the occurrence of bright moonlight during the last week has made observations somewhat difficult.

THE RECENT ECLIPSE EXPEDITIONS.—Further news is to hand regarding some of the observers who went out to observe the total eclipse of the sun. The *Morning Post* of September 3 gives some information about the party from the Royal Observatory, Greenwich, through Mr. Hepburn. Mr. Hepburn accompanied this party as a volunteer assistant to Minsk, in Russia, and they observed the eclipse under satisfactory conditions. He left there on the Sunday after the eclipse, but while most of the plates exposed were then not developed, one that was developed showed the spectrum of the chromosphere. Mr. Hepburn arrived in England on September 1 *viâ* Finland, Norway, and the North Sea, and he expected the official members of the party to be home on about September 6. It is stated that the instruments will be sent to the Russian Imperial Observatory at Pulkovo, where Prof. Backlund, the director, has arranged to keep them pending a favourable opportunity to return them to Greenwich. Mr. R. C. Slater had arranged to go to Riga (Russia) to make his observations, and sent his instruments there direct. He found, according to the *Times* of August 31, that he was unable to cross the Baltic. Having with him only a 4-in. lens he rigged up a camera and made his observations at Strömsum, in Sweden. With this he was successful, and he is recorded to have brought back with him excellent photographs of the corona.

THE MIRRORS OF THE HELWAN KHEDIVIAL OBSERVATORY.—Bulletin No. 12 of the Khedivial Observatory at Helwan is devoted to accounts of the photographic tests of the figures of the new and old thirty-inch mirrors by Messrs. Walter S. Adams and H. Knox-Shaw respectively. The new mirror, the gift of Mr. Astor, was figured by Mr. Ritchey at Pasadena, and the method of testing was that of Hartmann. In the first tests a small amount of astigmatism was indicated in the zones along the 0° and 90° diameters, but none along the 45° and 135° diameters, or, in other words, the figure of revolution of the mirror was fairly good. A comparison of the computed and observed values of the focal lengths of the zones showed that the central zones were still greatly undercorrected. Further work in the mirror by Mr. Ritchey has greatly improved it, and a second series of tests has indicated that the agreement of the observed with the theoretical figure is remarkably close; in fact Mr. Adams states that "the mirror may accordingly be regarded as essentially perfect to within the limit defined in this way." A similar set of tests made by Mr. Knox-Shaw on the old thirty-inch Common mirror *in situ* in the telescope. He found that the mirror was uncorrected by about twice as much as was the Ritchey mirror at the time of the first series of tests mentioned above. From tests of the astigmatism he concludes that the position of the telescope has an appreciable effect on the figure of the mirror as has been suspected to be the case.

PLANT-LIFE AT THE SNOW-LINE.[1]

MR. JOSIAS BRAUN'S exhaustive account of the vegetation at the snow-line in the south-eastern (Rhætian-Lepontine) Alps forms a valuable contribution to our knowledge of the plant-ecology of the Swiss Alps. The area includes, roughly speaking, the country from the St. Gothard to the Engadine. The text consists of two parts. The first is a consideration of the vegetation in relation to external conditions, with a detailed description of the plant-associations. The zone under consideration is defined as that in which the summer heat just suffices to melt the annual heavy snow-fall on level areas; its altitude ranges from 2960 metres on the Bernina chain to 2650 metres in the St. Gothard group. It lies above the region of close turf, and forms a part of the open rock region. Within it the author distinguishes three secondary zones: (1) the "Pionierrasengurtel," the isolated outposts, so to say, of the turf-flora, forming patches in wind-sheltered places or on sunny spots; (2) the "Dicotyledonous zone," characterised mainly by cushion-forming Dicotyledonous plants; and (3) the "Thallophyte-zone" of rock-inhabiting lichens. The principal natural formations in the first zone are the Curvuletum, of which *Carex curvula* is a characteristic component, and the Elynetum, in which *Elyna myosuroides* predominates. Here, too, are found the last traces of the influence of man and his domesticated animals, indicated by luxuriance of *Poa alpina*. The last chapter of the first part deals with the fauna of the area, which comprises ninety-one species, mainly insects and spiders.

The second part comprises a systematic account of the flora. This includes two ferns, *Cystopteris fragilis* and *Asplenium viride, Botrychium lunaria, Lycopodium selago, Juniperus communis* var. *montana*, and 219 angiospermous flowering plants. The latter represent twenty-nine families, those most in evidence being, in order of numerical preponderance., Compositæ, Gramineæ, Caryophyllaceæ, Saxifragaceæ, Cruciferæ, Rosaceæ, Leguminosæ, Gentianaceæ, and Primulaceæ, which together contain two-thirds of the whole flora. The proportion of Monocotyledons to Dicotyledons is slightly less than at lower levels, namely, 1 : 4·3 as compared with 1 : 3·6. There are nine woody plants: Juniper, three Willows, *Empetrum nigrum, Loiseleuria (Azalea) procumbens*, and three species of Vaccinium. The best represented genera are Saxifraga, sixteen species; Gentiana, ten species; Carex, nine species; Festuca, Draba, and Cerastium, each with six species; and Alchemilla and Primula each with five. A comparison with the Arctic flora of the west coast of Greenland, between N. lat. 69° and 71°, which contains approximately the same number of flowering plants, shows considerable agreement between the two. There is, however, a much greater proportion of marsh plants in the Arctic flora, while in the Alpine the families Compositæ, Primulaceæ, Gentianaceæ, and Leguminosæ are more richly represented.

The author groups the snow-flora of this district of the Alps under five main headings: (1) an endemic-Alpine element, peculiar to the Alps, comprising twenty-nine species (13 per cent.); (2) a European-Alpine element with ninety-five species (42·4 per cent.); (3) a Eurasiatic element with fourteen species (6·2 per cent.), which occur also in Central Asia, but do not reach the polar circle; (4) an Arctic-Alpine element with seventy-one species (31·7 per cent.); (5) a ubiquitous element, fifteen species (6·7 per cent.), of more widely distributed plants in lower levels.

RECENT WORK ON ENTOMOLOGY.

THE American representatives of the minute homopterous insects commonly known as jumping plant-lice (Psylliidæ) form the subject of an elaborate memoir by Mr. D. L. Crawford, published as Bulletin No. 85 (168 pp.) of the U.S. National Museum. These widely-spread insects frequent trees and shrubs, where, from their active habits, they are difficult to capture without the aid of a net. When disturbed, they throw themselves into the air by means of their powerful hind-legs, and when once launched, are able to propel themselves some considerable distance by rapidly vibrating the wings, although they are not endowed with the power of prolonged flight.

Mr. Crawford found the current classification of the group—largely based on wing-venation—to be altogether untrustworthy, closely related species being in many instances placed in different genera. A more satisfactory basis for classification is afforded by the structure of the head; and from this and other features the author proposes a new taxonomic scheme, with the description of many new species.

Cicalas and other Homoptera collected during the second expedition of the Duke Adolf Friedrich of Mecklenburg are described by Dr. L. Melichar in Lief. 5 of Band i. of *Ergebnisse der Zweiten Deutschen Zentral-Afrika-Expedition*, 1910–11. The collection included 184 specimens, referable to 65 species, of which 18 appeared to be new, some of these likewise representing three new genera types.

In the first article of Lief. 4 of the publication just quoted, Prof. Y. Sjöstedt records the white ants observed and obtained during the expedition. Special interest attaches to photographs of the interior of a nest of *Termites natalensis*, showing, not only a "fungus-garden," but also the royal cells, of which one contains the monstrous, overgrown queen, and a second, in close proximity, the diminutive king.

In connection with the above may be noticed the description, by Mr. S. Hozawa, in *Annot. Zool. Japon*, vol. viii., parts 3 and 4, of a new species of termite-eating beetle from Formosa. It belongs to the tenebrionid genus, Zielas, previously known only by a single species from Annam, of which the habits have not been observed, although, from its affinity to termitophilous genera, it has been assumed to feed on white ants. The elongated eyes, degenerate hind-wings, and sluggish movements of the Formosan species are doubtless connected with its mode of life.

Three issues of the Journal of the College of Agriculture, Tohoku Imperial University, Sapporo, Japan, are to hand, two of which (vol. v., parts 6 and 7) are devoted to various groups of Japanese insects, with descriptions of a number of new species and genera, while the third (vol. vi., part 1) contains further observations on reduplication in silkworms.

Pine timber in a district in Montana, between the Swan and Clearwater rivers, is seriously menaced by the larvæ of the sequoia pitch-moth (*Vespamima sequoiae*). According to a leaflet by Mr. J. Brunner, issued as Bulletin No. 111 of the U.S. Department of Agriculture, it specially attacks the so-called lodgepole pine, in which it propagates; other trees in the vicinity of those attacked are endangered by the forest-fires fed by the timber killed by the larvæ. Destruction of the larvæ themselves seems the only efficient preventive of the infestation.

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[1] Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles, vol. xviii. Pp. vii+347+map+4 plates.

Experiments recently undertaken in the United States, as recorded by Mr. B. R. Cond, in vol. ii., No. 3, of the *Journal of Agricultural Research*, have shown that the larvæ of the boll-weevil (*Anthorromus gravelis*) can and do feed on plants other than cotton, as, for example, on *Hibiscus syriacus*.

The Board of Agriculture has issued a leaflet (No. 286) on the two species of narcissus-flies, *Merodon equestris* and *Eumerus strigatus*, the grubs of which attack the bulbs of daffodils and other narcissi. The first and larger species, which was, at one time, supposed to have been introduced from the continent into this country, where it has been recognised since 1869, but in the opinion of at least one economic entomologist is probably indigenous, although it only became abundant with the development of daffodil-culture. The second and smaller species is a recent introduction, but, from its destructive nature, is likely to become as serious a pest as the first. The life-history of each species is described, with suggestions for remedial measures.

The July and August numbers of the *Entomologist's Monthly Magazine* contain two instalments of an account, by Mr. J. J. Walker, R.N., of the spread of the American butterfly *Danaida plexippus* to the islands of the south Pacific and Australia. Following one of its food-plants—a milk-weed of the genus Asclepias—it appears to have reached Hawaii between 1845 and 1850, whence a gravid female (or possibly a pair) was probably carried to Ponape, in the Caroline group. From this solitary individual (or pair) have probably sprung the swarms now spread over the South Sea islands, in many of which this species is the commonest of all butterflies.

The most important item in Prof. G. H. Carpenter's report on injurious insects in Ireland during 1913 (Economic Proc., R. Dublin Soc., vol. ii., No. 9), relates to the damage caused by the frit-fly (*Oscinis frit*) to corn crops. This little black fly is a recent introduction to Ireland, and in May and June of last year its maggots were very destructive to a field of oats in Tyrone. Its early life-history is detailed in an article by Mr. T. R. Hewitt in vol. xiv., No. 23, of the Scientific Proceedings of the Royal Dublin Society; and this account is incorporated in Prof. Carpenter's report. R. L.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY SIR CHARLES P. LUCAS, K.C.B., K.C.M.G., PRESIDENT OF THE SECTION.

Man as a Geographical Agency.

IN an inaugural address to the Royal Scottish Geographical Society on geography and statecraft Lord Milner said: "If I have no right to call myself a geographer, I am at least a firm believer in the value of geographical studies." I wish to echo these words. I have no expert geographical knowledge, and am wholly unversed in science, but I am emboldened to try to say a few words because of my profound belief in the value of geographical studies. I believe in their value partly on general grounds, and largely because a study of the British Empire leads an Englishman, whether born in England or in Australia, to the inevitable conclusion that statecraft in the past would have been better, if there had been more accurate knowledge of geography. This statement might be illustrated by various anecdotes, some true, not a few apocryphal; but anecdotes do not lend themselves to the advancement of science. I am encouraged, too, to speak because the field of geography is more open to the man in the street than are the sciences more strictly so-called. It is a *graphy*, not a *logy*. Geology is the science of the earth. Geography is a description of the face of the earth and of what is on or under it, a series of pictures with appropriate letterpress and with more or less appropriate morals to adorn the tale. The man in the street may talk affably and even intelligently about the face of the earth.

Taking the earth as it is, geographical discovery has well-nigh reached its limit. The truth, in the words of Addison's hymn, is now "spread from Pole to Pole," and recent exploration at the South Pole, with its tale of heroism, will have specially appealed to the citizens of this Southern land. Coasts are in most cases accurately known. The age of Cook and Flinders is past. Interiors are more or less known. In Africa there is no more room for Livingstones, Spekes, Burtons, and Stanleys. In Australia Sir John Forrest is an honoured survival of the exploring age—the age of McDouall Stuart and other heroes of Australian discovery. The old map-makers, in Swift's well-known lines, "o'er unhabitable downs placed elephants for want of towns." Towns have now taken the place of elephants and of kangaroos. Much, no doubt, still remains to be done. The known will be made far better known; maps will be rectified; many great inland tracts in Australia and elsewhere will be, as they are now being, scientifically surveyed; corners of the earth only penetrated now will be swept and garnished. But as we stand to-day, broadly speaking, there are few more lands and seas to conquer. Discovery pure and simple is passing away.

But meanwhile there is one side of geography which is coming more and more to the front, bringing it more than ever within the scope of the British Association for the Advancement of Science. "Man is the ultimate term in the geographical problem," said Dr. Scott Keltie some years since at the meeting at Toronto. "Geography is a description of the earth as it is, in relation to man," said Sir Clements Markham, long president of the Royal Geographical Society. Geography, I venture to think, is becoming more and more a description of the earth as it is and as it will be under the working hand of man. It is becoming intensive rather than extensive. Geographers have to record, and will more and more have to record, how far man has changed and is changing the face of the earth, to try to predict how far he will change it in the coming centuries. The face of the earth has been unveiled by man. Will the earth save her face in the years before us, and, if she saves her face, will it be taken at face value? How far, for instance, will lines of latitude and longitude continue to have any practical meaning?

Man includes the ordinary man, the settler, the agriculturist; man includes, too, the extraordinary—the man of science, the inventor, the engineer. "Man," says a writer on the subject, "is truly a geographical agency," and I ask you to take account of this agency for a few minutes. I do so more especially because one of the chief features of the present day is the rise of the South; and the rise of the South—notably of Australia—is the direct result of human agency, on one hand transforming the surface of the land, on the other eliminating distance. The old name of Australia, as we all know, was New Holland. The name was well chosen in view of later history, for while no two parts of the world could be more unlike one another than the little corner of Europe known as Holland, or the Netherlands, and the great Southern Continent, in one and in the other man has been pre-eminently a geographical agency.

The writer who used this phrase, "Man is a geographical agency," the American writer, Mr. G. P. Marsh, published his book, "Man and Nature," in 1864, and a new edition, entitled "The Earth as Modified by Human Action," in 1874. He was mainly concerned with the destructiveness of man in the geographical and climatic changes which he has effected. "Every plant, every animal," he writes, "is a geographical agency, man a destructive, vegetables, and in some cases even wild beasts, restorative powers"; and again: "It is in general true that the intervention of man has hitherto seemed to ensure the final exhaustion, ruin, and desolation of every province of Nature which he has reduced to his dominion." The more civilised man has become, he tells us, the more he has destroyed. "Purely untutored humanity interferes comparatively little with the arrangements of Nature, and the destructive agency of man becomes more and more energetic and unsparing as he advances in civilisation." In short, in his opinion, "better fifty years of Cathay than a cycle of Europe."

He took this gloomy view mainly on account of the mischief done by cutting down forests. Man has wrought this destruction not only with his own hand, but through domesticated animals more destructive than wild beasts, sheep, goats, horned cattle, stunting or killing the young shoots of trees. Writing of Tunisia, Mr. Perkins, the Principal of Roseworthy College, says: "In so far as young trees and shrubs are concerned, the passage of a flock of goats will do quite as much damage as a bush fire." Mr. Marsh seems to have met a fool in the forest, and it was man; and he found him to be more knave than fool, for man has been, in Mr. Marsh's view, the revolutionary Radical confiscating Nature's vested interests. "Man," he says, "has too long forgotten that the earth was given to him for usufruct alone, not for consumption, still less for profligate waste." Trees, to his mind, are Conservatives of the best kind. They stand in the way, it is true, but they stop excesses, they moderate the climate, they give shelter against the wind, they store the water, prevent inundations, preserve and enrich the soil. "The clearing of the woods," he says, "has in some cases produced within two or three generations effects as blasting as those generally ascribed to geological convulsions, and has laid waste the face of the earth more hopelessly than if it had been buried by a current of lava or a shower of volcanic sand"; and, once more, where forests have been destroyed, he says, "The face of the earth is no longer a sponge but a dust-heap."

The damage done by cutting down trees, and thereby letting loose torrents which wash away the soil, is or was very marked in the south of France, in Dauphiné, Provence, and the French Alps. With the felling of trees and the pasturing of sheep on the upper edge of the forest—for sheep break the soil and expose the roots—the higher ground has been laid bare. Rainstorms have in consequence swept off the soil, and the floods have devastated the valleys. The mountainsides have become deserts, and the valleys have been turned into swamps. "When they destroyed the forest," wrote the great French geographer, Reclus, about thirty years ago, "they also destroyed the very ground on which it stood"; and then he continues: "The devastating action of the streams in the French Alps is a very curious phenomenon from the historical point of view, for it explains why so many of the districts of Syria, Greece, Asia Minor, Africa, and Spain have been forsaken by their inhabitants. The men have disappeared along with the trees; the axe of the woodman, no less than the sword of the conqueror, has put an end to, or transplanted, entire populations." In the latter part of the South African war Sir William Willcocks, skilled in irrigation in Egypt, and now reclaiming Mesopotamia, was brought to South Africa to report upon the possibilities of irrigation there, and in his report dated November 1901 he wrote as follows: "Seeing in Basutoland the effect of about thirty years of cultivation and more or less intense habitation convinced me of the fact that another country with steep slopes and thin depth of soil, like Palestine, has been almost completely denuded by hundreds of years of cultivation and intense habits. The Palestine which Joshua conquered and which the children of Israel inhabited was in all probability covered over great part of its area by sufficient earth to provide food for a population a hundred times as dense as that which can be supported to-day." The Scotch geologist, Hugh Miller, again, attributed the formation of the Scotch mosses to the cutting down of timber by Roman soldiers. "What had been an overturned forest became in the course of years a deep morass."

In past times there have been voices raised in favour of the forests, but they have been voices crying in the desert which man has made. Here is one. The old chronicler Holinshed, who lived in the reign of Queen Elizabeth, noted the amount of timber cut down for house building and in order to increase the area for pasturage. "Every small occasion in my time," he writes, "is enough to cut down a great wood"; and in another passage either he himself or one of his collaborators writes that he would wish to live to see four things reformed in England: "The want of discipline in the Church, the covetous dealing of most of our merchants in the preferment of commodities of other countries and hindrance of their own, the holding of fairs and markets upon the Sunday to be abolished and referred to the Wednesdays, and that every man in whatever part of the champaine soil enjoyeth forty acres of land and upwards after that rate, either by free deed, copyhold or fee farm, might plant one acre of wood or sow the same with oke mast, hazell, beach, and sufficient provision be made that it be cherished and kept."

Mr. Marsh seems to have thought that the Old World, and especially the countries which formed the old Roman Empire, had been ruined almost past redemption; and for the beneficent action of man on Nature he looked across the seas. "Australia and New Zealand," he writes, "are perhaps the countries from which we have a right to expect the fullest elucidation of these difficult and disputable problems. Here exist greater facilities and stronger motives for the careful study of the topics in question than have ever been found combined in any other theatre of European colonisation."

His book was first written half a century ago. He was a pessimist evidently, and pessimists exaggerate even more than optimists, for there is nothing more exhilarating and consoling to ourselves than to predict the worst possible consequences from our neighbour's folly. Further, though it may be true that man became more destructive as he became more civilised, it is also true that the destruction has been wrought directly rather by the unscientific than by the man of science. If we have not grown less destructive since, at any rate we have shown some signs of penitence, and science has come to our aid in the work of reparation. Governments and associations have directed their attention to protecting woodland and reafforesting tracts which have been laid bare. The Touring Club of France, for instance, I am told, have taken up the question of the damage done by destruction of trees by men and sheep in Haute Savoie, and they assist reclamation by guidance and by grants. In England, under the auspices of Birmingham University and under the Presidency of Sir Oliver Lodge, the Midlands Reafforestation Association is planting the pit mounds and ash quarries of the Black Country with trees which will resist smoke and bad air, alders, willows, poplars, carrying out their work, a report says, under a combination of difficulties not to be found in any other country. Artificial lakes and reservoirs again, such as I shall refer to presently, are being made woodland centres. In most civilised countries nowadays living creatures are to some extent protected, tree planting is encouraged by Arbour days, and reserves are formed for forests, for beasts and birds, the survivors of the wild fauna of the earth. Some lands, such as Greece, as I gather from Mr. Perkins' report, are still being denuded of trees, but as a general rule the human conscience is becoming more and more alive to the immorality and the impolicy of wasting the surface of the earth and what lives upon it, and is even beginning to take stock as to whether the minerals beneath the surface are inexhaustible. Therefore I ask you now to consider man as the lord of creation in the nobler sense of the phrase as transforming geography, but more as a creative than as a destructive agency.

How far has the agency of man altered, and how far is it likely to alter, the surface of the earth, the divisions and boundaries assigned by Nature, the climate, and the production of the different parts of the globe; and, further, how far, when not actually transforming Nature, is human agency giving Nature the go-by? It should be borne in mind that science has effected, and is effecting transformation, partly by applying to old processes far more powerful machinery, partly by introducing new processes altogether; and that, as each new force is brought to light, lands and peoples are to a greater or less extent transformed. The world was laid out afresh by coal and steam. A new readjustment is taking place with the development of water power and oil power. Lands with no coal, but with fine water power or access to oil, are asserting themselves. Oil fuel is prolonging continuous voyages and making coaling stations superfluous. But of necessity it is the earth itself which gives the machinery for altering its own surface. The application of the machinery is contributed by the wit of man.

The surface of the earth consists of land and water. How far has human agency converted water into land or land into water, and how far, without actually transforming land into water and water into land, is it for practical human purposes altering the meaning of land and water as the great geographical divisions? A writer on the Fens and South Lincolnshire has told us: "The Romans, not content with appropriating land all over the world, added to their territory at home by draining lakes and reclaiming marshes." We can instance another great race which, while appropriating land all over the world, has added to it by reclaiming land from water, fresh or salt. The traveller from Great Britain to the most distant of the great British possessions, New Zealand, will find on landing at Wellington a fine street, Lambton Quay, the foreshore of the old beach, seaward of which now rise many of the city's finest buildings on land reclaimed from the sea; and instances of the kind might be indefinitely multiplied. Now the amount of land taken from water by man has been taken more from fresh water than from sea, and, taken in all, the amount is infinitesimal as compared with the total area of land and water; but it has been very considerable in certain small areas of the earth's surface, and from these small areas have come races of men who have profoundly modified the geography and history of the world. This may be illustrated from the Netherlands and from Great Britain.

Motley, at the beginning of "The Dutch Republic," writes of the Netherlands: "A region, outcast of ocean and earth, wrested at last from both domains their richest treasures." Napoleon was credited with saying that the Netherlands were a deposit of the Rhine, and the rightful property of him who controlled the sources; and an old writer pronounced that Holland was the gift of the ocean and of the rivers Rhine and Meuse, as Egypt is of the river Nile. The crowning vision of Goethe's Faust is that of a free people on a free soil, won from the sea and kept for human habitation by the daily effort of man. Such has been the story of the Netherlands. The Netherlands, as a home for civilised men, were, and are, the result of reclamation, of dykes and polders. The kingdom has a constantly changing area of between 12,000 and 13,000 square miles. Mr. Marsh, in his book, set down the total amount gained to agriculture at the time he wrote "by dyking out the sea and by draining shallow bays and lakes" at some 1370 square miles, which, he says, was one-tenth of the kingdom; at the same time, he estimated that much more had been lost to the sea—something like 2600 square miles. He writes that there were no important sea dykes before the thirteenth century, and that draining inland lakes did not begin until the fifteenth, when windmills came into use for pumping. In the nineteenth century steam pumps took the place of windmills, science strengthening an already existing process. Between 1815 and 1855, 172 square miles were reclaimed, and this included the Lake of Haarlem, some thirteen miles long by six in breadth, with an area of about seventy-three square miles. This was reclaimed between 1840 and 1853. At the present time, we are told, about forty square miles are being reclaimed annually in Holland; and meanwhile the Dutch Government has in contemplation or in hand a great scheme for draining the Zuyder Zee, which amounts to recovering from the ocean land which was taken by it in historic times at the end of the fourteenth century. The scheme is to be carried out in thirty-three years and is to cost nearly sixteen million pounds. The reclamation is to be effected by an embankment across the mouth of this inland sea over eighteen miles long. The result will be to add 815 square miles of land to the kingdom of the Netherlands, 750 square miles of which will be fertile land, and in addition to create a much-needed freshwater lake with an area of 557 square miles; this lake is to be fed by one of the mouths of the Rhine.

London is partly built on marsh. The part of London where I live, Pimlico, was largely built on piles. A little way north, in the centre of fashion, is Belgrave Square, and here a lady whom I used to know had heard her grandfather say that he had shot snipe. Take the City of London in the strict and narrow sense. The names of Moorfields and Fensbury or Finsbury are familiar to those who know the City. Stow, in his Survey of London, more than three hundred years ago, wrote of "The Moorfield which lieth without the postern called Moorgate. This field of old time was called the Moor. This fen or moor field, stretching from the wall of the city betwixt Bishopsgate and the postern called Cripplegate to Fensbury and to Holywell continued a waste and unprofitable ground a long time." By 1527, he tells us, it was drained "into the course of Walbrook, and so into the Thames, and by these degrees was this fen or moor at length made main and hard ground, which before, being overgrown with flags, sedges and rushes, served to no use." It is said that this fen or marsh had come into being since Roman times. The reclamation which has been carried out in the case of London is typical of what has been done in numerous other cases. As man has become more civilised, he has come down from his earlier home in the uplands, has drained the valley swamps, and on the firm land thus created has planted the streets and houses of great cities.

The Romans had a hand in the draining of Romney Marsh in Sussex, and here nature cooperated with man, just as she has cooperated in the deltas of the great rivers, for the present state of the old Cinque Ports, Rye and Winchelsea, shows how much on this section of the English coast the sea has receded. But the largest reclamation was in East Anglia, where the names of the Fens and the Isle of Ely testify to what the surface once was. "For some of our fens," writes Holinshed, "are well known to be either of ten, twelve, sixteen, twenty or thirty miles in length. . . . Wherein also Elie, the famous isle, standeth, which is seven miles every way, and whereunto there is no access but by three causies." Arthur Young, in 1799, in his "General View of the Agriculture of the County of Lincoln," a copy of which he dedicated to that great friend of Australia, Sir Joseph Banks, who was a Lincolnshire landowner and a keen supporter of reclamation, wrote of the draining which had been carried out in Lincolnshire. "The quantity of land thus added to the kingdom has been great; fens of water, mud, wild fowl, frogs and agues have been converted to rich pasture and arable worth from 20*s*. to 40*s*. an acre . . . without going back to very remote periods, there cannot have been less than 150,000 acres drained and improved on an average from 5*s*. an acre to 25*s*." 150,000 acres is about 234 square miles, but the amount reclaimed by draining in Lincolnshire in the seventeenth, eighteenth and nineteenth centuries seems to have been more than 500 square miles. The Fenlands as a whole extended into six counties. They were seventy miles in length, from ten to thirty miles broad, and covered an area of from 800 to 1000 square miles. One estimate I have seen is as high as 1200 square miles. Mr. Prothero, in his book on "English Farming, Past and Present," tells us that they were "in the seventeenth century a wilderness of bogs, pools and reed shoals—a vast morass from which here and there emerged a few islands of solid earth." In the seventeenth century a Dutch engineer, Vermuyden, was called in to advise, and the result of draining what was called after the peer who contracted for it the Bedford Level, together with subsequent reclamations, was to convert into ploughland and pasture large tracts which, in the words of an old writer, Dugdale, had been "a vast and deep fen, affording little benefit to the realm other than fish or fowl, with overmuch harbour to a rude and almost barbarous sort of lazy and beggarly people." In Lincolnshire there was a district called Holland, and in Norfolk one called Marshland, said to have been drained by, to quote Dugdale again, "those active and industrious people, the Romans."

The Dutch and the English, who thus added to their home lands by reclamation, went far and wide through the world, changing its face as they went. The Dutch, where they planted themselves, planted trees also; and when they came to land like their own Netherlands, again they reclaimed and empoldered. The foreshore of British Guiana, with its canals and sea defences, dating from Dutch times, is now the chief sugar-producing area in the British West Indies. If again in Australia man has been a geographical agency, he learnt his trade when he was changing the face of his old home in the British Isles.

Instances of reclaiming land from water might be indefinitely multiplied. We might compare the work done by different nations. In Norway, for instance, Reclus wrote that "the agriculturists are now reclaiming every year forty square miles of the marshes and fiords." Miss Semple, who, in the "Influences of Geographic Environment," writes that "between the Elbe and Scheldt" (that is, including with the Netherlands some of North Germany) "more than 2000 square miles have been reclaimed from river and sea in the past 300 years," tells us also that "the most gigantic dyke system in the world is that of the Hoangho, by which a territory of the size of England is won from the water for cultivation." Or we might take the different objects which have impelled men here and there to dry up water and bank out sea. Agriculture has not been the only object, nor yet reclaiming for town sites. Thus, in order to work the hematite iron mines at Hodbarrow, in Cumberland, an area of 170 acres was, in the years 1900–04, reclaimed from the sea by a barrier more than $1\frac{1}{4}$ miles long, designed by the great firm of marine engineers, Coode and Matthews, which built the Colombo breakwater. The reclaimed land, owing to the subsidence caused by the workings, is now much below the level of the sea. Here is an instance of reclamation not adding to agricultural or pastoral area, but giving mineral wealth, thereby attracting population and enriching a district.

How far has land been drowned by the agency of man? Again the total area is a negligible quantity, but again, relatively to small areas, it has been appreciable, and the indirect effects have been great. The necessities of town life are responsible for new lakes and rivers. Such are the great reservoirs and aqueducts by which water is being brought to New York from the Catskill Mountains, a work which a writer in the *Times* has described as "hardly second in magnitude and importance to the Panama Canal." In Great Britain cities in search of a water supply have ordered houses, churches, fields to be drowned, and small lakes to come into existence. Liverpool created Lake Vyrnwy in Montgomeryshire, with a length of nearly five miles and an area of 1121 acres. Birmingham is the parent of a similar lake in a wild Radnorshire valley near my old home. The water is not carried for anything like the distance from Mundaring to Kalgoorlie, and on a much greater scale than these little lakes in Wales is the reservoir now being formed in New South Wales by the Burrinjuck dam, on the Murrumbidgee River, which, as I read, is, or will be, forty-one miles long, and cover an area of twenty square miles. If I understand right, in this case, by holding up the waters of a river, a long narrow lake has been or is being called into existence. A still larger volume of water is gathered by the great Assouan dam, which holds up the Nile at the head of the First Cataract, washing, and at times submerging, the old temples on the Island of Philæ in mid-stream. First completed in 1902, the dam was enlarged and heightened by 1912; and the result of the dam is at the time of high Nile to create a lake of some 65 square miles in area, as well as to fill up the channel of the river for many miles up stream. Illustrations of artificial lakes might be multiplied from irrigation works in India. An official report on the State of Hyderabad, written some years ago, has the following reference to the tanks in the granitic country of that State: "There are no natural lakes, but from the earliest times advantage has been taken of the undulating character of the country to dam up some low ground or gorge between two hills, above which the drainage of a large area is collected. Such artificial reservoirs are peculiar to the granitic country, and wherever groups of granite hills occur tanks are sure to be found associated with them." Take again the great ship canals. The Suez Canal runs for 100 miles from sea to sea, though for part of its course it runs through water, not through sand. It is constantly growing in depth and width. Its original depth was 26½ ft.; it is now, for nine-tenths of its length, more than 36 ft., and the canal is to be further deepened generally to more than 39 ft. Its original width at the bottom was 72 ft.; it is now, for most of its course, more than 147 ft.; in other words, the width has been more than doubled. A writer in the *Times* on the wonderful Panama Canal said: "The locks and the Gatun dam have entailed a far larger displacement of the earth's surface than has ever been attempted by the hand of man in so limited a space." Outside the locks the depth is 45 ft., and the minimum bottom width 300 ft. The official handbook of the Panama Canal says: "It is a lake canal as well as a lock canal, its dominating feature being Gatun Lake, a great body of water covering about 164 square miles." The canal is only fifty miles long from open sea to open sea, from shore line to shore line only forty. But in making it man, the geographical agency, has blocked the waters of a river, the Chagres, by building up a ridge which connects the two lines of hills between which the river flows, this ridge being a dam 1½ miles long, nearly half a mile wide at its base, and rising to 105 ft. above sea-level, with the result that a lake has come into existence which is three-quarters of the size of the Lake of Geneva, and extends beyond the limits of the Canal zone.

Mr. Marsh, in his book, referred to far more colossal schemes for turning land into water, such as flooding the African Sahara or cutting a canal from the Mediterranean to the Jordan and this submerging the basin of the Dead Sea, which is below the level of the ocean. The effect of the latter scheme, he estimated, would be to add from 2000 to 3000 square miles to the fluid surface of Syria. All that can be said is that the wildcat schemes of one century often become the domesticated possibilities of the next and the accomplished facts of the third; that the more discovery of new lands passes out of sight the more men's energies and imagination will be concentrated upon developing and altering what is in their keeping; and that, judging from the past, no unscientific man can safely set any limit whatever to the future achievements of science.

But now, given that the proportion of land to water and water to land has not been, and assuming that it will not be, appreciably altered, has water, for practical purposes, encroached on land, or land on water? In many cases water transport has encroached on land transport. The great isthmus canals are an obvious instance; so are the great Canadian canals. The tonnage passing through the locks of the Sault St.-Marie is greater than that which is carried through the Suez Canal. Waterways are made where there was dry land, and more often existing inland waterways are converted into sea-going ways. Manchester has become a seaport through its Ship Canal. The Clyde, in Mr. Vernon Harcourt's words, written in 1895, has been "converted from an insignificant stream into a deep navigable river capable of giving access to ocean-going vessels of large draught up to Glasgow." In 1758 the Clyde at low water at Glasgow was only 15 inches deep, and until 1818 no seagoing vessels came up to Glasgow. In 1895 the depth at low water was from 17 to 20 ft., and steamers with a maximum draught of 25½ ft. could go up to Glasgow. This was the result of dredging, deepening and widening the river, and increasing the tidal flow. The record of the Tyne has been similar. The effect of dredging the Tyne was that in 1895—I quote Mr. Harcourt again—"Between Shields and Newcastle, where formerly steamers of only 3 to 4 ft. draught used to ground for hours, there is now a depth of 20 ft. throughout at the lowest tides." It is because engineers have artificially improved Nature's work on the Clyde and the Tyne that these rivers have become homes of shipbuilding for the whole world. Building training walls on the Seine placed Rouen, seventy-eight miles up the river, high among the seaports of France. The Elbe and the Rhine, the giant rivers Mississippi and St. Lawrence, and many other rivers, have, as we all know, been wonderfully transformed by the hand of the engineer.

But land in turn, in this matter of transport, has encroached upon sea. In old days, when roads were few and bad, when there were no railways, and when ships were small, it was all-important to bring goods by water at all parts as far inland as possible. In England there were numerous flourishing little ports in all the estuaries and up the rivers, which, under modern conditions, have decayed. No one now thinks of Canterbury and Winchester in connection with seaborne traffic; but Mr. Belloc, in "The Old Road," a description of the historical Pilgrims' Way from Winchester to Canterbury, points out how these two old-world cathedral cities took their origin and derived their importance from the fact that each of them, Canterbury in particular, was within easy reach of the coast, where a crossing from France would be made; each on a river—in the case of Canterbury on the Stour just above the end of the tideway. In the days when the Island of Thanet was really an island, separated from the rest of Kent by an arm of the sea, and when the present insignificant river Stour was, in the words of the historian J. R. Green, "a wide and navigable estuary," Canterbury was a focus to which the merchandise of six Kentish seaports was brought, to pass on inland; it was in effect practically a seaport. Now merchandise, except purely local traffic, comes to a few large ports only, and is carried direct by rail to great distant inland centres. Reclus wrote that bays are constantly losing in comparative importance as the inland ways of rapid communication increase; that, in all countries intersected with railways, indentations in the coast-line have become rather an obstacle than an advantage; and that maritime commerce tends more and more to take for its starting-place ports situated at the end of a peninsula. He argues, in short, that traffic goes on land as far out to sea as possible instead of being brought by water as far inland as possible. He clearly overstated the case, but my contention is that, for human purposes, the coast-line, though the same on the map, has practically been altered by human agency. Ports have been brought to men as much as men to ports. We see before our eyes the process going on of bridging India to Ceylon so as to carry goods and passengers as far by land as possible, and in Ceylon we see the great natural harbour of Trincomalee practically deserted and a wonderful artificial harbour created at the centre of population, Colombo.

But let us carry the argument a little further. Great Britain is an island. Unless there is some great convulsion of Nature, to all time the Straits of Dover will separate it from the continent of Europe. Yet we have at this moment a renewal of the scheme for a Channel tunnel, and at this moment men are flying from England to France and France to England. Suppose the Channel tunnel to be made; suppose flying to be improved—and it is improving every day—what will become of the island? What will become of the sea?

They will be there and will be shown on the map, but to all human intents and purposes the geography will be changed. The sea will no longer be a barrier, it will no longer be the only high-road from England to France. There will be going to and fro on or in dry land, and going to and fro neither on land nor on sea. Suppose this science of aviation to make great strides, and heavy loads to be carried in the air, what will become of the ports, and what will become of sea-going peoples? The ports will be there, appearing as now on the map, but Birmingham goods will be shipped at Birmingham for foreign parts, and Lithgow will export mineral direct, saying good-bye to the Blue Mountains and even to Sydney Harbour.

Now, in saying this I may well be told by my scientific colleagues that it is all very well as a pretty piece of fooling, but that it is not business. I say it as an unscientific man with a profound belief in the limitless possibilities of science. How long is it since it was an axiom that, as a lump of iron sinks in water, a ship made of iron could not possibly float? Is it fatuous to contemplate that the conquest of the air, which is now beginning, will make it a highway for commercial purposes? We have aeroplanes already which settle on the water and rise again; we are following on the track of the gulls which we wonder at far away in the limitless waste of ocean. A century and a half ago the great Edmund Burke ridiculed the idea of representatives of the old North American colonies sitting in the Imperial Parliament; he spoke of any such scheme as fighting with Nature and conquering the order of Providence; he took the distance, the time which would be involved—six weeks from the present United States to London. If anyone had told him that what is happening now through the applied forces of science might happen, he would have called him a madman. Men think in years, or at most in lifetimes; they ought sometimes to think in centuries. I believe in Reclus's words, "All man has hitherto done is a trifle in comparison with what he will be able to effect in future." Science is like a woman. She says No again and again, but means Yes in the end.

In dealing with land and water I have touched upon natural divisions and natural boundaries, which are one of the provinces of geography. Flying gives the go-by to all natural divisions and boundaries, even the sea; but let us come down to the earth. Isthmuses are natural divisions between seas; the ship canals cut them and link the seas—the canal through the Isthmus of Corinth, the canal which cuts the Isthmus of Perekop between the Crimea and the mainland of Russia, the Baltic Canal, the Suez Canal, the Panama Canal. The Suez Canal, it will be noted, though not such a wonderful feat as the Panama Canal, is more important from a geographical point of view, in that an open cut has been made from sea to sea without necessity for locks, which surmount the land barrier but more or less leave it standing. Inland, what are natural divisions? Mountains, forests, deserts, and, to some extent, rivers. Take mountains. "High, massive mountain systems," writes Miss Semple, "present the most effective barriers which man meets on the land surface of the earth." But are the Rocky Mountains, for instance, boundaries, dividing-lines, to anything like the extent that they were now that railways go through and over them, carrying hundreds of human beings back and fore day by day? On what terms did British Columbia join the Dominion of Canada? That the natural barrier between them should be pierced by the railway. Take the Alps. The canton Ticino, running down to Lake Maggiore, is politically in Switzerland; it is wholly on the southern side of the Alps. Is not the position entirely changed by the St. Gothard tunnel, running from Swiss territory into Swiss territory on either side of the mountains?

If, in the Bible language, it requires faith to remove mountains, it is not wholly so with other natural boundaries. Forests were, in old days, very real natural dividing-lines. They were so in England, as in our own day they have been in Central Africa. Between forty and fifty years ago, in his "Historical Maps of England," Prof. C. H. Pearson, whose name is well known and honoured in Australia, laid down that England was settled from east and west, because over against Gaul were heavy woods, greater barriers than the sea. Kent was cut off from Central England by the Andred Weald, said to have been, in King Alfred's time, 120 miles long and 30 broad. Here are Prof. Pearson's words: "The axe of the woodman clearing away the forests, the labour of nameless generations reclaiming the fringes of the fens or making their islands habitable, have gradually transformed England into one country, inhabited by one people. But the early influences of the woods and fens are to isolate and divide." Thus the cutting down of trees is sometimes a good, not an evil, and there are some natural boundaries which man can wholly obliterate.

Can the same be said of deserts? They can certainly be pierced, like isthmuses and like mountains. The Australian desert is a natural division between Western and South Australia. The desert will be there, at any rate for many a long day after the transcontinental railway has been finished, but will it be, in anything like the same sense as before, a barrier placed by Nature and respected by man? Nor do railways end with simply giving continuous communication, except when they are in tunnels. As we all know, if population is available, they bring in their train development of the land through which they pass. Are these deserts of the earth always going to remain "deserts idle"? Is man going to obliterate them? In the days to come, will the desert rejoice and blossom as the rose? What will dry farming and what will afforestation have to say? In the evidence taken in Australia by the Dominions Royal Commission, the Commissioner for Irrigation in New South Wales tells us that "the dry farming areas are carried out westward into what are regarded as arid lands every year," and that, in his opinion, "we are merely on the fringe of dry farming" in Australia. A book has lately been published entitled "The Conquest of the Desert." The writer, Dr. Macdonald, deals with the Kalahari Desert in South Africa, which he knows well, and for the conquest of the desert he lays down that three things are essential—population, conservation, and afforestation. He points out in words which might have been embodied in Mr. Marsh's book, how the desert zone has advanced through the reckless cutting of trees, and how it can be flung back again by tree barriers to the sand dunes. By conservation he means the system of dry farming so successful in the United States of America, which preserves the moisture in the soil and makes the desert produce fine crops of durum wheat without a drop of rain falling upon it from seedtime to harvest, and he addresses his book "to the million settlers of to-morrow upon the dry and desert lands of South Africa." If the settlers come, he holds that the agency of man, tree-planting, ploughing and harrowing the soil, will drive back and kill out the desert. The effect of tree-planting in arresting the sand dunes and reclaiming desert has been very marked in the Landes of Gascony. Here, I gather from Mr. Perkins' report, are some 3600 square miles of sandy waste, more than half of which had, so far back as 1882, been converted into forest land, planted mainly with maritime pines.

What, again, will irrigation have to say to the deserts? Irrigation, whether from underground or from overground waters, has already changed the face of the earth, and as the years go on, as knowledge grows and wisdom, must inevitably change it more and more. I read of underground waters in the Kalahari. I read of them too in the Libyan Desert. In the *Geographical Journal* for 1902 it is stated that at that date nearly 22,000 square miles in the Algerian Sahara had been reclaimed with water from artesian wells. What artesian and sub-artesian water has done for Australia you all know. If it is not so much available for agricultural purposes, it has enabled flocks and herds to live and thrive in what would be otherwise arid areas. Prof. J. W. Gregory, Mr. Gibbons Cox, and others have written on this subject with expert knowledge; evidence has been collected and published by the Dominions Royal Commission, but I must leave to more learned and more controversial men than I am to discuss whether the supplies are plutonic or meteoric, and how far in this matter you are living on your capital.

If we turn to irrigation from overground waters, I hesitate to take illustrations from Australia, because my theme is the blotting out of the desert, and most of the Australian lands which are being irrigated from rivers, and made scenes of closer settlement, would be libelled if classed as desert. Mr. Elwood Mead told the Royal Commission that the State irrigation works in Victoria, already completed or in process of construction, can irrigate more than 600 square miles, and that, if the whole water supply of the State were utilised, more like 6000 square miles might be irrigated. The Burrinjuck scheme in New South Wales will irrigate in the first instance not far short of 500 square miles, but may eventually be made available for six times that area. If we turn to irrigation works in India, it appears from the second edition of Mr. Buckley's work on the subject, published in 1905, that one canal system alone, that of the Chenab in the Panjab, had, to quote his words, turned "some two million acres of wilderness (more than 3000 square miles) into sheets of luxuriant crops." "Before the construction of the canal," he writes, "it was almost entirely waste, with an extremely small population, which was mostly nomad. Some portion of the country was wooded with jungle trees, some was covered with small scrub camel thorn, and large tracts were absolutely bare, producing only on occasions a brilliant mirage of unbounded sheets of fictitious water." The Chenab irrigation works have provided for more than a million of human beings; and, taking the whole of India, the Irrigation Commission of 1901–3 estimated that the amount of irrigated land at that date was 68,750 square miles; in other words, a considerably larger area than England and Wales. Sir William Willcocks is now reclaiming the delta of the Euphrates and Tigris. The area is given as nearly 19,000 square miles, and it is described as about two-thirds desert and one-third freshwater swamp. More than 4000 square miles of the Gezireh Plain, between the Blue and the White Nile, are about to be reclaimed, mainly for cotton cultivation, by constructing a dam on the Blue Nile at Sennaar and cutting a canal 100 miles long which, if I understand right, will join the White Nile, thirty miles south of Khartoum.

With the advance of science, with the growing pressure of population on the surface of the earth, forcing on reclamation as a necessity for life, is it too much to contemplate that human agency in the coming time will largely obliterate the deserts which now appear on our maps? It is for the young peoples of the British Empire to take a lead in—to quote a phrase from Lord Durham's great report—"the war with the wilderness, and the great feat of carrying water for 350 miles to Kalgoorlie, in the very heart of the wilderness, shows that Australians are second to none in the ranks of this war.

It is a commonplace that rivers do not make good boundaries because they are easy to cross by boat or bridge. Pascal says of them that they are "des chemins qui marchent" (roads that move), and we have seen how these roads have been and are being improved by man. "Rivers unite," says Miss Semple; and again, "Rivers may serve as political lines of demarcation, and therefore fix political frontiers, but they can never take the place of natural boundaries." All the same, in old times at any rate, rivers were very appreciable dividing-lines, and when you get back to something like barbarism, that is to say in time of war, it is realised how powerful a barrier is a river. Taking, then, rivers as in some sort natural boundaries, or treating them only as political boundaries, the point which I wish to emphasise is that they are becoming boundaries which, with modern scientific appliances, may be shifted at the will of man. In the days to come the diversion of rivers may become the diversion of a new race of despotic rulers with infinitely greater power to carry out their will or their whim than the Pharaohs possessed when they built the Pyramids. You in Australia know how thorny a question is that of the control of the Murray and its tributaries. There are Waterways Conventions between Canada and the United States. Security for the head-waters of the Nile was, and is, a prime necessity for the Sudan and Egypt. The Euphrates is being turned from one channel into another. What infinite possibilities of political and geographical complications does man's growing control over the flow of rivers present!

Thus I have given you four kinds of barriers or divisions set by Nature upon the face of the earth—mountains, forests, deserts, rivers. The first, the mountains, man cannot remove, but he can and he does go through them to save the trouble and difficulty of going over them. The second, the forests, he has largely cleared away altogether. The third, the deserts, he is beginning to treat like the forests. The fourth, the rivers, he is beginning to shift when it suits his purpose and to regulate their flow at will.

I turn to climate. Climates are hot or cold, wet or dry, healthy or unhealthy. Here our old friends the trees have much to say. Climates beyond dispute become at once hotter and colder when trees have been cut down and the face of the earth has been laid bare; they become dryer or moister according as trees are destroyed or trees are planted and hold the moisture; the cutting and planting of timber affects either one way or the other the health of a district. The tilling of the soil modifies the climate. This has been the case, according to general opinion, in the North-West of Canada, though I have not been able to secure any official statistics on the subject. In winter time broken or ploughed land does not hold the snow and ice to the same extent as the unbroken surface of the prairie; on the other hand, it is more retentive at once of moisture and of the rays of the sun. The result is that the wheat zone has moved further north, and that the intervention of man has, at any rate for agricultural purposes, made the climate of the great Canadian North-West perceptibly more favourable than it was. In Lord Strathcona's view, there was some change even before the settlers came in, as soon as the rails and telegraph lines of the Canadian Pacific Railway were laid. He told me that in carrying the line across a desert belt it was found that, within measurable distance of the rail and the telegraph line, there was a distinct increase of dew and moisture. I must leave it to men of science to say whether this was the result of some electrical or other force, or whether what was observed was due simply to a wet cycle coinciding with the laying of the rails and the erection of the wires. I am told that it is probably a coincidence of this kind which accounts for the fact that in the neighbourhood of the Assouan dam there is at present a small annual rainfall, whereas in past years the locality was rainless. Reference has already been made to the effect of cultivation in the Kalahari Desert in increasing the storage of moisture in the soil. But it is when we come to the division between healthy and unhealthy climates that the effect of science upon climate is most clearly seen. The great researches of Ross, Manson, and many other men of science, British and foreign alike, who have traced malaria and yellow fever back to the mosquito, and assured the prevention and gradual extirpation of tropical diseases, bid fair to revolutionise climatic control. Note, however, that in our penitent desire to preserve the wild fauna of the earth we are also establishing preserves for mosquitos, trypanosomes and the tsetse fly.

Nowhere have the triumphs of medical science been more conspicuous than where engineers have performed their greatest feats. De Lesseps decided that Ismailia should be the headquarters of the Suez Canal, but the prevalence of malaria made it necessary to transfer the headquarters to Port Said. In 1886 there were 2300 cases of malaria at Ismailia; in 1900 almost exactly the same number. In 1901 Sir Ronald Ross was called in to advise; in 1906 there were no fresh cases, and malaria has been stamped out. Lesseps's attempt to construct the Panama Canal was defeated largely, if not mainly, by the frightful death-rate among the labourers; 50,000 lives are said to have been lost, the result of malaria and yellow fever. When the Americans took up the enterprise they started with sending in doctors and sanitary experts, and the result of splendid medical skill and sanitary administration was that malaria and yellow fever were practically killed out. The Panama Canal is a glorious creation of medical as well as of engineering science, and this change of climate has been mainly due to reclamation of pools and swamps, and to cutting down bush, for even the virtuous trees, under some conditions, conduce to malaria. Man is a geographical agency, and in no respect more than in the effect of his handiwork on climate, for climate determines products, human and others. Science is deciding that animal pests shall be extirpated in the tropics, and that there shall be no climates which shall be barred to white men on the ground of danger of infection from tropical diseases.

If we turn to products, it is almost superfluous to give illustrations of the changes wrought by man. As the incoming white man has in many places supplanted the coloured aboriginal, so the plants and the living creatures brought in by the white man have in many cases, as you know well, ousted the flora and fauna of the soil. Here is one well-known illustration of the immigration of plants. Charles Darwin, on the voyage of the *Beagle,* visited the island of St. Helena in the year 1836. He wrote "that the number of plants now found on the island is 746, and that out of these fifty-two alone are indigenous species." The immigrants, he said, had been imported mainly from England, but some from Australia, and, he continued, "the many imported species must have destroyed some of the native kinds, and it is only on the highest and steepest ridges that the indigenous flora is now predominant."

Set yourselves to write a geography of Australia as Australia was when first made known to Europe, and compare it with a geography now. Suppose Australia to have been fully discovered when Europeans first reached it, but consider the surface then and the surface now, and the living things upon the surface then and now. Will not man have been found to be a geographical agency? How much waste land, how many fringes of desert have been reclaimed? The wilderness has become pasture land, and pasture land, in turn, is being converted into arable. The Blue Mountains, which barred the way to the interior, are now a health resort. Let us see what Sir Joseph Banks wrote after his visit to Australia on Captain Cook's first voyage in 1770. He has a chapter headed "Some Account of that part of New Holland now called New South Wales." New Holland he thought "in every respect the most barren country I have seen"; "the fertile soil bears no kind of proportion to that which seems by nature doomed to everlasting barrenness." "In the whole length of coast which we sailed along there was a very unusual sameness to be observed in the face of the country. Barren it may justly be called, and in a very high degree, so far, at least, as we saw." It is true that he only saw the land by the sea, but it was the richer eastern side of Australia, the outer edge of New South Wales and Queensland. What animals did he find in Australia? He "saw an animal as large as a greyhound, of a mouse colour, and very swift." "He was not only like a greyhound in size and running, but had a tail as long as any greyhound's. What to liken him to I could not tell." Banks had a greyhound with him, which chased this animal. "We observed, much to our surprise, that, instead of going upon all fours, this animal went only on two legs, making vast bounds." He found out that the natives called it kangaroo, and it was "as large as a middling lamb." He found "this immense tract of land," which he said was considerably larger than all Europe, "thinly inhabited, even to admiration, at least that part of it that we saw." He noted the Indians, as he called them, whom he thought "a very pusillanimous people." They "seemed to have no idea of traffic"; they had "a wooden weapon made like a short scimitar." Suppose a new Sir Joseph Banks came down from the planet Mars to visit Australia at this moment, what account would he give of it in a geographical handbook for the children of Mars? He would modify the views about barrenness, if he saw the cornfields and flocks and herds; if he visited Adelaide, he would change his opinion as to scanty population, though not so, perhaps, if he went to the back blocks. He would record that the population was almost entirely white, apparently akin to a certain race in the North Sea, from which, by tradition, they had come; that their worst enemies could not call them pusillanimous; that they had some ideas of traffic, and used other weapons than a wooden scimitar; and he would probably give the first place in animal life not to the animal like a greyhound on two legs, but to the middling lamb, or perhaps to the ubiquitous rabbit. Australia is the same island continent that it always was; there are the same indentations of coast, the same mountains and rivers, but the face of the land is different. In past years there was no town, and the country was wilderness; on the surface of the wilderness many of the living things were different; and from under the earth has come water and mineral, the existence of which was not suspected. A century hence it will be different again, and I want to see sets of maps illustrating more clearly than is now the case the changes which successive generations of men have made and are making in the face of Australia and of the whole earth.

More than half a century ago Buckle, in his "History of Civilisation," wrote: "Formerly the richest countries were those in which Nature was most bountiful; now the richest countries are those in which man is most active. For in our age of the world, if Nature is parsimonious we know how to compensate her deficiencies. If a river is difficult to navigate, or a country difficult to traverse, an engineer can correct the error and remedy the evil. If we have no rivers we make canals; if we have no natural harbours we make artificial ones." These words have a double force at the present day and in the present surroundings, for nowhere has man been more active as a geographical agency than in Australia; and not inside Australia only, but also in regard to the relations of Australia to the outside world.

An island continent Australia is still, and always will be, on the maps. It always will be the same number of miles distant from other lands; but will these maps represent practical everyday facts? What do miles mean when it takes a perpetually diminishing time to cover them? Is it not truer to facts to measure distances, as do Swiss guides, in Stunden (hours)? What, once more, will an island continent mean if the sea is to be overlooked and overflown? The tendency is for the world to become one; and we know perfectly well that, so far as distance is concerned, for practical purposes the geographical position of Australia has changed through the agency of scientific man. If you come to think of it, what geography has been more concerned with than anything else, directly or indirectly, is distance. It is the knowledge of other places not at our actual door that we teach in geography, how to get there, what to find when we get there, and so forth. The greatest revolution that is being worked in human life is the elimination of distance, and this elimination is going on apace. It is entering into every phase of public and private life, and is changing it more and more. The most difficult and dangerous of all Imperial problems at this moment is the colour problem, and this has been entirely created by human agency, scientific agency, bringing the lands of the coloured and the white men closer together. Year after year, because distance is being diminished, coming and going of men and of products is multiplying; steadily and surely the world is becoming one continent. This is what I want geographers to note and the peoples to learn. Geographers have recorded what the world is according to Nature. I want them to note and teach others to note how under an all-wise Providence it is being subdued, replenished, recast, and contracted by man.

SECTION G.

ENGINEERING.

Opening Address by Prof. E. G. Coker, M.A., D.Sc., President of the Section.

The subject of stress distribution in materials, which I have chosen for this address, is not one which an engineer can claim as his peculiar province, for it has been and still is a fruitful field of investigation for the mathematician, the physicist, and the geologist, and has always been so since the commencement of scientific inquiry; indeed, it must have been the source of speculation and controversy ever since mankind emerged from a primitive state, and began to fashion dwellings, weapons, and tools from the materials at command.

The development of architecture from the earliest dwellings of savage races to the great temples of Egypt and Greece, the bridges and aqueducts of the Romans, and the mediæval buildings of Europe, all bear witness to the accumulation of practical knowledge of the properties of materials and of the stress distribution in structures, which we cannot fail to admire, although we know far too little of the way in which these ancient structures were planned and constructed. The magnificent arched and domed buildings of the Roman period, and the stately cathedrals of later times with their wealth of architectural form—tower and spire, flying buttress and vaulting—all show how considerable was the practical knowledge of stress distribution possessed by the master builders who planned and carried out these great structures. We, who inherit these buildings as a precious legacy of bygone ages, have at our command far greater resources in the accumulated knowledge of centuries of scientific discovery and invention, and can build more complex structures—great bridges of steel, towering frameworks covered by a thin veneer of masonry, and floating arsenals of the most bewildering intricacy. All these we can show to our credit as the result of the steady increase of scientific knowledge applied to practical ends, but, even now, knowledge of the stresses which come upon these complex structures and machines is relatively small. Scientific investigations of engineering problems of stress still lag behind constructive ability, and defective knowledge is obscured more or less by approximate theories and buttressed by factors of safety, which serve in one instance perhaps, but show in others that they have merely given a sense of fancied security with no real basis, and are more properly factors of ignorance, to be discarded at the earliest moment. Who, for example, can say with certainty what is the stress distribution throughout the compression members of a great bridge, built up of complicated steel shapes and plates, united by stiffening angles, gusset plates, and innumerable rivets. There is probably good reason for the belief that a great strut is relatively weaker than a small one, when both are designed according to the same approximate formulæ now used in current practice, and engineers are unwilling to take the responsibility for such members in a great structure, without providing a very ample margin of safety to cover the contingencies arising from lack of precise knowledge of the strength of these members. So numerous are the problems which arise in the design and construction of machines and structures, that it is perhaps not unprofitable to devote a short hour to the consideration of some of the available means which an engineer can use as a guide for his applications of science to construction, since of whatever kind are the professional activities he pursues, his place in the scheme of affairs mainly depends on his ability to make machines and structures for directing and modifying natural sources of power in known ways, or applying them to new purposes as scientific discoveries advance the boundaries of knowledge.

The power to do this depends, to no small extent, upon the ability to determine the distribution of stress in a structure, and the skilful manner in which material can be disposed for the required purpose.

It is of some help to our appreciation of the achievements of the great constructors of past ages, if we remember that they probably all held the erroneous view that materials of construction are perfectly rigid bodies, and, indeed, we know that as late as 1638 Galileo Galilei was of that opinion, and that he came to an entirely wrong conclusion as regards the stress distribution in a loaded cantilever.

It required the genius and insight of Robert Hooke to make a really great step, with his celebrated theory of the linear relation of stress to strain, and we can appreciate the glow of pride and satisfaction which he must have felt at his great discovery, when he records in 1675 that "his Majesty was pleased to see the experiment that made out this theory tried at Whitehall, as also my spring watch."

Hooke had, in fact, discovered the fundamental principle upon which a theory of the elasticity and strength of materials could be based, and it would be interesting to trace the great advances which were rapidly made from this new vantage ground, whereby the main facts of the distribution of stress in simple members of structures became known, and a foundation was laid for the great advances of the mathematical theory. If I am silent upon the enormous developments of the modern theory of the strength of materials it is not from lack of appreciation, but because I do not deem myself adequately fitted to discuss the great work of the elasticians, which all engineers admire, and so few are equipped to follow with the full battery of mathematical tools which have been pressed into service in the pursuit of this great science.

Among the greatest of the services rendered by early pioneers was that of Young, who was the first to notice that the elastic resistance of a body to shear was different from its resistance to extension or contraction, and this led him to define a modulus of elasticity for materials in compression. As Prof. Love remarks, "This introduction of a definite physical concept, which descends, as it were, from a clear sky on the readers of mathematical memoirs, marks an epoch in the history of the science."

From the viewpoint of the engineer, nothing is of more practical importance than the great discoveries of Hooke and Young, that bodies like metal, wood, and stone are "springy" and have a simple linear relation between stress and strain. It is probably within the mark to say that nine-tenths of all the experimental investigations on stress distributions in structures have been entirely based on the fundamental principles which they enunciated, and new uses are continually arising. The recent application of the steam turbine to the propulsion of ships produced a profound change in marine-engine practice, and incidentally involved an entire reconstruction of methods for obtaining the horse-power developed, which had been gradually perfected from the time of Watt, but were absolutely useless for the new system of propulsion. Hooke's discovery of the essential springiness of metals enabled engineers quickly to devise new instruments capable of accurately measuring the infinitesimal angular distortions of propeller shafts, and from these to determine the horse-power transmitted by the aid of an appropriate modulus.

The construction of tall buildings affords another example where advantage has been taken to determine the loads upon columns by measuring the minute diminutions of length as the structure proceeds, thereby affording a valuable check upon the calculations for these members, and a trustworthy indication of the pressures supported by the foundations.

The distribution of stress in buildings constructed of composite materials like concrete reinforced with steel has also been examined by similar methods, and much data for guidance in future constructional work has been obtained, especially in the United States of America.

The still more difficult problems involved in the determination of the stresses in joints and fastenings of complicated structures have often been investigated by purely mechanical measurements of strain, and the experimental investigations of Profs. Barraclough and Gibson and their pupils upon the distribution of stress due to riveted joints and curved plates of boiler shells afford a notable example of the successful application of the measurement of small strains to a stress problem of great complexity.

That "science of measurement" is here sufficiently obvious, and it seems only due to the memory of that great engineer, Sir Joseph Whitworth, to refer to his great mechanical achievements of a true plane and well-nigh perfect screw, which enabled him to measure changes of one-millionth of an inch, and thereby gave experimental investigations of strains of a new impetus, which is reflected in subsequent work on the subject. Nor must we forget the no less important exposition, by Kelvin and Tait, of the scientific principles of instrument construction which have done so much for the design of instruments for the precise measurement of strains.

Mechanical measurements cannot, however, completely satisfy all our modern requirements, since they are essentially average values, and fail to accommodate themselves to many of the problems which press for solution.

In the quest for exact experimental knowledge, the measurement of stress at a point becomes of paramount importance, and we may, therefore, inquire what further means the researches of pure science have placed at our disposal for the determination of stress distribution in materials.

It is well known that many materials when tested to destruction show a considerable rise of temperature at the place of fracture, especially in very ductile materials; but Weber was the first to discover that a metal wire when stretched within the elastic limit is cooled by the action of the load, and this result was deduced later from the laws of thermo-elastic behaviour of materials by Lord Kelvin, who showed that tension and compression loads produce opposite effects, and that materials which have the property of contracting with rise of temperature show thermal effects of the reverse kind. Although the changes of temperature produced by stress are small within the elastic range—less than 1° C. for most materials—yet their effect upon a thermo-couple is readily measurable if the equilibrating effects of surrounding bodies are neutralised or allowed for, so that stress distribution can be determined by thermal measurements at a point. The correction for such disturbing causes is usually an important factor, and is generally so large that experimental work is more suitable for the laboratory than the workshop; but if all necessary precautions are taken a linear relation of stress to strain can be shown to hold up to the elastic limit of the material, while above this point the breakdown of the structure causes a rise of temperature of so marked a character that it has been utilised by several investigators as an indication of the yield point.

Experiments upon members subjected to tension, compression, and bending, show that thermal phenomena afford trustworthy indications of the stress in materials so diverse as a rolled-steel section, a block of cement, and beams of stone and slate. Although no attempt appears to have been made to investigate stress distributions of any great complexity, it seems not unlikely that thermal methods of investigation will ultimately prove of considerable value.

The transparency of metals to Röntgen rays is another phenomenon which has often been suggested as likely to be of service for work on stress distribution in materials, and Mr. Howgrave Graham and I have examined a number of rolled metals under stress up to the breaking point, without, however, discovering any change in the appearance of the material as seen on a fluorescent screen. Although our experiments showed no perceptible change, it is, of course, not impossible that an effect may have escaped our notice.

Another and still more fascinating field of research on stress distribution is afforded by the doubly refractive properties of transparent bodies under stress, a discovery made by Sir David Brewster almost exactly one hundred years ago, and but rarely made use of since by engineers, although Brewster himself immediately saw its value for experimental purposes, and suggested that models of arches might be made of glass, and the effects of stresses due to loading rendered visible in polarised light.

Brewster carried his investigations further, by the invention of a "chromatic teinometer" for investigating the nature of strains, and consisting of plates or bars of glass subjected to flexure in definite ways for comparison with the body under stress.

At a much later date (1841) Neumann developed an elaborate theory for the analysis of strain in transparent bodies due to load, unequal temperature, and set, while, still later, the youthful genius of Clerk-Maxwell supplied an algebraical solution for the stress distribution in any plate subjected to stresses in its own plane.

The early history of the development of this branch of science is, in fact, remarkable for notable contributions at long intervals of time, and the almost complete disregard by engineers of its practical importance.

The application of optical investigation to the determination of stress distribution in engineering structures and machines has, however, been hindered by causes which, although apparently insignificant, have been very real obstacles, and among these was the absence of a transparent material which could be fashioned into shapes suitable for investigating technical problems. It is not an easy matter, for example, to construct a glass model of a bridge free from internal stress, in the manner suggested by Brewster; and, moreover, glass is extremely fragile under load, especially in cases where the stress distribution in it varies very much, while the cost of construction is very great. Happily there is now no necessity to employ glass for experimental investigation on engineering problems, since modern chemistry has supplied artificial bodies, such as the nitro-cellulose compounds used for many trade purposes, which have optical properties very little inferior to glass, are able to bear great stresses without injury, and also are capable of being fashioned with the ease and certainty of a wooden model. Photographic processes are also able to reproduce the brilliant colour effects caused by stress in transparent materials, so that permanent records can now be made for future reference.

The construction of polariscopes for examining models on a large scale is very essential for technical research, and the great scarcity of Iceland spar of sufficient purity and size for use as Nicol's prisms has caused much attention to be paid to the construction of apparatus for producing plane polarised light by the aid of sheets of glass. Fortunately this presents little difficulty, and although the light is not nearly so well polarised as that obtained from a Nicol's prism it is sufficiently so for the purpose. Large quarter-wave plates of mica have also been constructed by my colleague, Prof. Silvanus Thompson, for obtaining circularly polarised light, and these have proved sufficiently exact and exceedingly useful for large models.

It is of importance to show that the stress distribution revealed by a polarised beam of light passing through an elastic transparent material in no way differs from that obtained by other means, and evidence is available in modern researches, especially by Filon, that the experimental results obtained with glass agree with those of the theory of elasticity, while a satisfactory agreement of a similar kind has also been obtained with nitro-cellulose compounds, although not in so complete and direct a manner. Such an agreement may be expected on theoretical grounds, since the values of elastic constants do not affect the fundamental equations for stresses in a plane, and although for three-dimensional stress the effect of the stretch-squeeze ratio causes some difference, yet this is usually negligible.

Most of the physical constants of glass have been determined with very considerable accuracy, but other transparent substances have so far received little attention, and their optical constants are not well known. The stress-strain relations of glass and nitro-cellulose have been determined with considerable accuracy, and a useful idea of their relation to metals may be gained from the value of the stretch-modulus, E, and the stretch-squeeze ratio, σ.

The accompanying table shows some average values for a few important materials, and it is of interest to note that the stretch-squeeze ratios of cast-iron and plate-glass are very similar, while the values of the stretch modulus are nearly as three to two. These two materials also possess other like characteristics: they are both very brittle, and possess well-developed crystalline structure, so that we may expect the properties of cast-iron under stress to be very faithfully followed by plate-glass.

Material	E	σ
Steel	30,000,000 ...	0·25
Wrought iron ...	28,000,000 ...	0·28
Cast iron	15,000,000 ...	0·25
Plate-glass ...	10,500,000 ...	0·23
Nitro-cellulose ...	260,000 to 300,000 ...	0·40

The high values of the stretch modulus for steel and wrought iron are not, apparently, approached by any transparent material having similar ductile properties, but although nitro-cellulose has a stretch modulus of rather less than one-hundredth that of steel, its stress-strain properties are not unlike. In some recent experiments with a miniature testing machine fitted with an arrangement for recording the stress-strain relations of xylonite throughout the whole range of stress up to fracture, the main characteristics of steel appear on a very reduced scale, and give additional confidence that the results of optical experiments on this material are applicable to metal structures.

The complete analysis of stress distribution in a plate is not, however, a simple matter, and the analysis of Clerk-Maxwell was intended to provide a solution based on the properties of the isochromatic and isoclinic lines, coupled with the law that the optical effect is proportional to the difference of the principal stresses at a point, and to the thickness of the plate.

A principal stress perpendicular to the bounding planes is assumed to have no optical effect; but since many cases have arisen where there are three principal stress components, it seemed desirable to examine such a case experimentally.

It is a matter of some difficulty to arrange apparatus to stress a specimen in the direction of the incident beam, and at the same time observe the optical effect free from disturbing causes, since a transparent medium must be interposed for applying the required load, and this will be subject to stresses which may interfere with the optical effect on the specimen.

Some observations on circular plates clamped at the edges and uniformly loaded over one face, showed that the bending stresses produced in the plate caused very little optical effect, since the tension and compression stresses neutralised one another, while the shear effects also appeared to be practically negligible. The only remaining stresses of importance were those caused by the clamping plates at the boundary, which produced radial and circumferential stresses having circular symmetry, and as the optical effects of these latter disappeared at a small distance from the edge, a field of view was obtained in which the optical effects of load applied perpendicularly to the plate were quite small, even when the internal stresses were very great.

Two circular plates clamped together to enclose a space between them may therefore be used as windows for observing the effect of a uniform pressure upon a transparent specimen, which latter may be a plate with its faces parallel to the end plates closing the chamber. If cubical compression is applied by a fluid, the principal stresses in the plane of the plate produce opposing optical effects, and any remaining effect is due to perpendicular pressures on the faces. The arrangement of experimental apparatus, therefore, took the form of a pair of transparent windows separated by an annular disc, and firmly clamped together by collars. The central chamber so formed was subjected to pressure of air, or other fluid, up to about one thousand pounds per square inch, and afterwards the specimen was introduced and the same pressure applied; but no visible change of effect could be observed. Finally, the specimen was set in the field of view outside the chamber, and pressure again applied by the fluid, but still no change was apparent. In all three cases the optical effects produced were small, and practically alike, so that the experimental evidence appears to warrant the conclusion that a principal stress in the direction of an incident beam of polarised light has no optical effect in a thin plate, or at any rate is so small that it may be neglected.

That the retardation between the ordinary and extraordinary rays is proportional to the stress difference perpendicular to the incident beam within the elastic limit of the material may, therefore, be taken as reasonably accurate, although future research may show that it is only an approximation, or even that it is more accurate to commence from a fundamental strain equation; but according to present knowledge there appears to be no warrant for such a procedure.

A more pressing difficulty arises with regard to the optical constant connecting the wave-length retardation with the stress difference. The recent researches of Filon on glass show that the value of this constant is curiously dependent on the previous history of the material, especially as regards its heat treatment. Until further knowledge is gained on this matter it appears to be necessary to guard against errors in stress measurement from this cause by a careful selection and treatment of the material used, since for other artificial bodies we may find that the variation in the constant is not less in magnitude, and is at least as complex as in glass. In some instances the stress optical coefficient may be dispensed with, and Filon has shown, in cases where a theory of stress distribution has been worked out and it is desired to compare it with the results of optical measurements, that the isoclinic lines offer many advantages, since they are independent of photo-elastic constants, and the material need only be subjected to small stresses.

The experimental analysis of stress distribution in a body depends on the possibility of finding the magnitudes and directions of the principal stresses at every point, and in practice it is found the simplest plan to determine the directions of stress from the lines of equal inclination obtained in plane polarised light, and to measure the stress difference by comparison with a wave-length standard, such as a Babinet compensator, or by comparison with a simple tension member set along one of the lines of principal stress, and loaded until the total effect produced is a dark field denoting a zero value. The difference of the principal stresses is then measured in terms of a simple tension. This alone is insufficient to determine the distribution, unless one of the principal stresses is zero, and, in general, another independent measure must be obtained. This is very conveniently supplied by the change in the lateral dimensions of the plate under stress, since this change may be taken, in the absence of a third principal stress, as proportional to the generalised sum of the principal stresses throughout the thickness.

The determination of the lateral strains in a comparatively thin plate, forming part of a model of a machine or structure, necessitates measurements of extremely minute linear quantities. If, for example, a plate of xylonite is taken, of the maximum thickness obtainable for optical work, a simple calculation shows that these strains must be measured to an accuracy of one- or two-millionths of an inch. Several instruments have been designed and constructed for this purpose, to fulfil conditions which appear to be essential for successful use. It is necessary to avoid all chance of injury to the surface of a transparent material, so that the measuring points of an instrument can only be pressed lightly against the surfaces, and the weight must, therefore, be supported independently of the model. In instruments so far constructed, the measuring mechanism is carried on a **U**-shaped frame, for convenience of movement from point to point of the specimen. One measuring needle is secured and operated by a calibrating screw, and the other is free to move a multiplying lever system, and thereby tilt a mirror to give an angular deflection, which latter is calibrated by reference to the standard screw when the instrument has been finally secured in place. In recent work the labour of accurately setting the instrument in a number of different positions has proved so great, that my assistant, Mr. F. H. Withycombe, has designed a useful adjunct in the form of a mechanical slide-rest, to effect the required changes easily and expeditiously. In one arrangement, a bracket carries the measuring instrument on a three-point support, and movement is effected by slides arranged to give displacements along three axes at right angles, and their amounts are measured by micrometer screws to an accuracy of rather less than one-thousandth of an inch.

These methods of stress determination avoid the difficulties of the Clerk-Maxwell analysis, which necessitates the determination of the equations to both families of isochromatic and isoclinic bands, usually a mathematical problem of considerable complexity. In some simple cases Mr. Scoble and I have verified the accuracy of the method of lateral measurements for determining the sum of the principal stresses, by comparing the calculated stresses with the experimental values obtained in a plate of transparent material. We have lately carried these experiments a stage further, and have shown that the measured sums of the principal stresses in steel agree with the calculated values. This experimental solution, in fact, gives the stress at a point in a plate, if the conditions are those assumed by the mathematical case of a plate where generalised equations of stress apply.

It is at once obvious, if the utility of experiments on models of this kind is admitted, that experimental evidence is available on a variety of practical engineering problems covering a very wide field of practice, not merely qualitative, but quantitative, and approximating to the needs of the physicist and mathematician, and well within the known variations of the materials with which the engineer has to deal in his daily practice.

During the last few years much attention has been paid to the determination of the stresses in structural elements of primary importance, but only a small number of cases have been examined, since even the simplest problems have proved somewhat difficult, and much time and labour have been spent in perfecting optical and mechanical appliances to suit the special conditions required for investigations on transparent models. A simple example of a case easily examined and of practical importance is that of a tension member subjected to an eccentric load. The optical effects here show a linear distribution of stress due to the combination of direct pull and bending, while the neutral axis moves towards the tension side as the stress increases. Not only can these effects be measured, but if the specimen begins to fail some indication is obtained of the way in which the stress distribution is changed to meet the new conditions, and there is found a tendency to an equalisation of the maximum stress at the boundary, although at present the form of the curve of distribution beyond the elastic limit is largely conjectural.

A case like that of a very short member subjected to direct compression is also not without interest, partly because it reveals unexpected difficulties. In the first place it is not easy to apply a pure compression stress, and if the surfaces in contact are not of the same materials it appears to be practically impossible, since the lateral changes are unlike, and shear stress is therefore produced at the plane of the surfaces in contact. In a short member this shear has a very important influence, and by interposing a thin layer of a material, such as india-rubber, between the pressure plates and the short transparent block, the artificial shear effect produced by the india-rubber is easily shown to influence the distribution throughout, and to increase the stress in a very marked way. Experiments on transparent materials show that the increase of stress may be twenty per cent. or even more. Such an effect is known to take place when cubes of stone are crushed between lead plates, and optical investigations on models have enabled a quantitative measure of the effect to be ascertained in this and other cases, thereby confirming the theoretical investigations of Filon on the distribution of stress in such members under various practical systems of loading.

The local effects produced near the points of application of a load are usually of considerable importance, and their influence on the stress distribution in beams has been examined by Carus-Wilson.

The stress effects produced by discontinuities in materials is also of considerable interest, and the cases arising from the necessities of construction are infinite in their variety.

The practical importance of an accurate knowledge of the change in stress distribution produced by changes of section in a member is so thoroughly appreciated that it needs no insistence, and it has received much attention from a mathematical point of view. Thus the local effect of a spherical cavity in a member subjected to uniform tension or compression load has been shown by Love to double the intensity very nearly, while Kirsch has shown that a small cylindrical hole in a tension member trebles the stress intensity. If the hole is elliptical the increase of stress may be still greater, and Inglis has shown, among other interesting cases, that if the minor axis of the ellipse is parallel to the direction of the applied load in a tension member, the stress intensity is increased by an amount measured by twice the ratio of the axis of the ellipse.

A crack, considered as the limiting case of an elliptical hole, is thus seen to give extremely great stresses at the ends, tending towards infinite values for an extremely fine crack.

Optical experiments afford an independent means of examining the alterations of stress intensity produced by discontinuities, and the results are found to agree remarkably well with those obtained from the theory of elasticity. The stress at the boundary of a small cylindrical hole in a plate has been found to be almost exactly three times the stress in the full plate, and the effects of holes comparable with the width of the tension member have also been examined in some detail.

In the case of a rivet just filling the hole and exerting no tangential effect at the boundary there is a lessened tension stress across the minimum section at the boundary hole, accompanied by a marked radial tension. These effects have been recently confirmed in a mathematical discussion by Suyehiro. Other cases give satisfactory agreement with calculation, and we may therefore feel some confidence that experimental investigation will prove useful in some of the very complicated cases arising out of engineering practice where analysis is difficult, if not impossible.

The effects of overstress in materials may also be examined by optical means, and although the laws relating to stress distribution in overstressed transparent material are not known, the general effects observed in simple cases are fairly evident. If, for example, a tension member of glass is stressed, there is no ductile yielding of the material, and the stress will therefore rise very rapidly at the boundary of a small hole, and fracture will therefore occur with a moderate load. If, however, a ductile transparent material is employed, and the material shows signs of failure at the hole, the breakdown of the structure spreads outwards as the load is increased, until we may have a condition in which within the elastic limit the curve of stress intensity at the minimum section accords with calculation, but at the overstressed part the stress tends to equalise, and the curve of intensity tends to become horizontal near the hole. The mean value of this part of the stress distribution may be inferred from the difference between the total load and the measured values below the region of failure; but the true distribution of the overstress has not been accurately determined, so that the shape of this peak is largely conjectural.

The effects of groups of rivets such as occur in bridges, boilers, and structural members of all kinds, afford ample scope for further inquiry; but before more exact knowledge can be gained of the condition of stress in a complicated riveted joint it appears necessary to examine thoroughly the very simple cases.

Mr. Scoble and I have examined the case of the load applied by one rivet to a plate with various amounts of overlap, and the stresses around the rivet holes had been measured with fair accuracy.

Other interesting cases of discontinuity in structure are afforded by the engine hatchways, gun-turrets, funnel openings, and the like, in ships' decks, and some progress in this direction has been made by experiments on model decks, subjected to loads like those produced when a vessel meets the waves due to a head sea.

Even if the utility of transparent models is left out of account, it is generally acknowledged that many engineering problems are often simplified by the use of models of machines and structures on a small scale, when circumstances forbid experimental examination of the actual work. No defence of their use is, I think, necessary, since the employment of models is a characteristic feature of British methods, not limited to engineers. Kelvin did not disdain their use, and his successors, who have done so much to advance knowledge of the æther and the atomic dust, have freely employed their great ingenuity in the construction of mechanical models and diagrams to explain their views, as in the Lodge cog-wheel diagrams of the æther, the planetary systems of atoms of J. J. Thomson and Rutherford, and the grouping of elements by Soddy.

Engineers have not the same great difficulties which confront those who are advancing the boundaries of pure science; their models are very much what they please to make them; but, even then, problems arise which are sufficiently difficult to tax all the resources of applied science. The behaviour of models considered as similar structures is, therefore, a subject which engineers are bound to investigate in order to determine the effects of fixed and moving loads, the action of wind, the pressure and frictional effects of steam and other fluids, and many other problems.

In the majority of cases the simplest and most direct method is the experimental study of a model, from which to obtain the data required for calculating effects on a full-sized structure, and hence the laws of similarity have received a very close scrutiny.

Although most valuable information can be obtained from models, their usefulness is clearly limited. The effects of the dead weight of a structure are proportional to the cube of the linear dimensions, and are, therefore, not usually measurable on a model except in exceptional circumstances, as, for instance, where elastic jellies are employed, as in the well-known investigations of Pearson on the stress distribution in reservoir dams. Nor are questions of stability easy to solve, since the forces producing instability are proportional to the size of the model. On the other hand, stress effects due to applications of load may be measured by the strains produced in a model of the same material, if the loads are proportional to the squares of the linear dimensions. The effects of applied load are studied even better in a model constructed of transparent material, since the variation of stress from point to point can be studied with much greater ease and certainty.

As detailed models of this latter kind present some variations from the usual laws of similarity, it may be of interest to indicate their nature. Questions of deformation clearly involve the elastic constants of the transparent material and their relation to those of the proposed structure, while stress distribution in the solid is influenced by the value of Poisson's ratio. This latter effect is quite small for glass, but may become appreciable with other substance. It is negligible in a model of any material which approximates to a thin plate stressed by forces in its own plane.

The optical effects for any given load are, moreover, independent of the thickness of the material, and depend upon the stress difference, so that colour effects are obtained which may be regarded as pictures of shear stress throughout the model. Modern researches on ductile materials like structural steel indicate that such materials fail at some limiting value of shearing stress, and since the place where these limiting values are reached in the model are visible to the eye, the weak places in the design of a structure can be ascertained and a faulty design corrected by purely experimental means.

In this connection it is of interest to mention that M. Mesnager, the chief engineer of bridges and roads to the French Government, has recently constructed an elaborate model in glass of a design of an arched bridge of about 310 feet span. This investigation was considered advisable for a work of this magnitude constructed of reinforced concrete, in order to check the calculations, especially of maximum stresses in the arched ribs, which latter were assumed to be fixed at the ends.

The effects of reinforcements were allowed for by determining equivalent sections of glass for the members of the model. Many difficulties had to be overcome in the production of a model free from optical defects, but these were all successfully surmounted. The stresses in the model were determined by aid of a Babinet compensator, and formed a valuable check upon the calculations for a structure of this great magnitude and somewhat unusual design.

In this brief and incomplete account of a small branch of applied science relating to engineering the fundamental importance of discoveries in pure science is manifest.

The discoveries in pure science and their innumerable applications to practical ends are ever a potent factor working for the common good, and the value which the British Association places upon applied science was most cordially voiced by Prof. Bateson in his Portsmouth address when he said: "To the creation of applicable science the very highest gifts and training are well devoted," and, "The man who devotes his life to applied science should be made to feel that he is in the main stream of scientific progress. If he is not, both his work and science at large will suffer. The opportunities of discovery are so few that we cannot afford to miss any, and it is to the man of trained mind, who is in contact with the phenomenon of a great applied science, that such opportunities are most often given"; and, again, "If we are to progress fast there must be no separation between pure and applied science. The practical man with his wide knowledge of specific natural facts, and the scientific student ever seeking to find the hard general truth which the diversity of Nature hides—truths out of which any lasting structure of progress must be built—have everything to gain from free interchange of experience and ideas."

Engineers who are more immediately concerned with the problems of directing the great sources of power in Nature for the use and convenience of man are indeed grateful to our president for these inspiring words, and trust that the ties which unite investigators in pure and applied science will never slacken, but will knit together more closely for a joint advance to a more perfect understanding and utilisation of the laws of Nature.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SHEFFIELD.—The council has decided to invite Dr. J. B. Leathes, F.R.S., professor of pathological chemistry in the University of Toronto, to accept the chair of physiology rendered vacant by the acceptance of Prof. J. S. Macdonald of the chair of physiology in the University of Liverpool.

A COPY of the calendar for the forthcoming session of the City of Bradford Technical College has been received. It provides full particulars of the various day courses arranged, prospectuses of the evening courses in different departments, and general guidance for intending students. The diploma of the college is awarded to each day student who has been in attendance for three complete sessions subsequent to passing the entrance examination, and has passed the college examinations in all subjects of the diploma course taken. The diploma courses in chemistry and in chemistry and dyeing extend over four years. The diploma courses afford a full training for the various branches of the textile, chemical, and engineering industries. Arrangements have been made with the

University of Leeds whereby students of the University or of the college have the use of certain equipment and other facilities at both institutions. Students remaining for a fourth year may take up advanced studies or research in a large number of branches of technological science. The associateship of the college, which confers several privileges, is awarded to certain students who, holding the college diploma, have attained their majority, had a year's practical experience with a firm engaged in their trade or profession subsequent to obtaining the diploma, and have submitted an approved original thesis.

THE calendar for the forthcoming session—the one hundred and nineteenth—of the Royal Technical College, Glasgow, is now available. It will be remembered that in 1913 the college became affiliated to the University of Glasgow. A university advisory joint-committee has been established, and a joint-board of studies in applied science and joint-boards of examiners in the same department representative of the university and the college, have been constituted. Candidates for the degree of B.Sc. in applied science may attend the necessary qualifying courses either in the university or in the college or in both, provided that the fees paid for graduating courses in the college are not less than those payable for corresponding courses in the university. The courses of study provided by the college in civil, mechanical, electrical, and mining engineering include the classes necessary for graduation in applied science. The University of Edinburgh has recognised the day classes of the college as qualifying for its degree of B.Sc., under certain regulations. Among other interesting arrangements explained in the calendar that may be mentioned by which a large number of engineering firms have expressed their willingness to allow a selected number of their apprentices facilities for carrying out a scheme of college study conjoined with practical work. The courses of study in engineering are held during the winter session of the college, and thus student-apprentices are left free to spend the intervening summers in works. The college provides practical instruction in all branches of technology, and the calendar gives full particulars of all for the use of intending students.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 24.—M. P. Appell in the chair.—B. **Baillaud**: Observations of the eclipse of the sun of August 21 made at the observatories of Algiers and Paris. At Algiers the eclipse was observed under good conditions. Thirty photographs were obtained, times of contact measured, and the ionisation studied. At Paris measurements were made of times of contact and four negatives were taken, but clouds interfered with the observations.—H. **Deslandres** and A. **Perot**: A second series of attempts to obtain a maximum magnetic field. The use of water with a new mode of cooling. The authors have aimed at the use of intense currents and large quantities of electrical energy rather than applying enormous masses of iron. The essential difficulty is the cooling of the bobbins carrying the high current, and an apparatus for effecting this with a current of water is described and illustrated. The maximum field obtained was 63,700 gauss, 22,900 of which was due to the iron core. The current used was 5000 amperes. A field of 50,000 gauss was obtained without an iron core (energy 340 kilowatts). The possibility of obtaining still higher fields by this method of winding and cooling is discussed.—M. **Bezssonoff**: The pigments of Fusarium. Two pigments are present: one yellow, belonging to the anthocyanic group; the other red, identified with carotine, described by Wildstäter.—E. **Maurié**: The nutritive value of ossein. The nitrogenous material contained in bones is of considerable nutritive value. Details of the mode of extraction are given.—J. **Danysz**: The treatment of trypanosomiasis by arsenical compounds, combined with salts of silver and antimony (products 88^2 and 102^i). The compound specially studied had the composition

$$[C_{12}H_{12}.O_2N_2.As_2].AgBr.SbO(H_2SO_4)_2,$$

and showed marked improvement in therapeutic properties against *Tr. surra* and *Tr. gambiense* as compared with compounds previous tried. In the case of the mice used for the experiments the fatal dose (per 20 grams) was 5 mgr., the tolerated dose 0·4 mgr. The ratio between the tolerated dose and the curative dose was 80 : 1 for *surra* and 100 : 1 for *Tr. gambiense*. Confirmative experiments were carried out on rabbits.—J. M. **Barbosa**: The bronchial sphincters in *Delphinus delphis*.

BOOKS RECEIVED.

Rendiconto dell' Accademia delle Scienze Fisiche e Matematiche. Serie 3a. Vol. xix. Fasc. 6–10; 11–12. Serie 3a. Vol. xx. Fasc. 1–4; 5–6. Serie Seconda. Vol. xv. (Napoli: Scienze Fisiche e Matematiche.)

The Standard Cyclopedia of Horticulture. By L. H. Bailey. Vol ii. Pp. 603–1200. (London: Macmillan and Co., Ltd.) 25*s.* net.

City of Bradford Technical College. Calendar for the Thirty-third Session, 1914–15. (Bradford.)

Contributions from Walker Museum. Vol. i., No. 8. The Osteology of Some American Permian Vertebrates. By S. W. Williston. Pp. 107–162. Chicago: University of Chicago Press; London: Cambridge University Press.) 1*s.* net.

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THURSDAY, SEPTEMBER 17, 1914.

THE CRETACEOUS FLORA.

Catalogue of the Mesozoic Plants in the British Museum (Natural History). The Cretaceous Flora. Part i., Bibliography, Algæ and Fungi. By Dr. Marie C. Stopes. Pp. xxiii + 285 + ii plates. (London: British Museum (Natural History): Longmans, Green and Co., 1913.) Price 12*s*.

DR. MARIE STOPES set herself a severe task in deciding to include in the catalogue of Cretaceous plants an exhaustive bibliography and list of species. The list of species from Cretaceous beds, described up to December 31, 1910, occupying nearly two hundred pages, affords a striking illustration of the large amount of material in palæobotanical literature that serves no useful purpose. While acknowledging that a list of this kind is valuable as a source of information, it is difficult to repress a certain suspicion that the result obtained is scarcely a fair return for the labour expended. As Dr. Stopes continues her investigations the value of the list will be considerably increased by the addition of critical remarks on such of the records as come under her purview. As it stands the catalogue of names may mislead the unwary who have not learnt by experience to regard with distrust a large proportion of determinations based on fragments of fossil Angiosperms; but as a storehouse of bibliographical information the list will be of real service to students. In the Introduction Dr. Stopes gives a useful summary of literature dealing with Cretaceous floras, and the stratigraphical table is a particularly welcome contribution which will do much to clear up the confusion caused by the adoption of different terms for subdivisions of the Cretaceous system in different countries. The publication of a list of dates of the parts of Brongniart's "Histoire des végétaux fossiles" is a much needed step towards a greater uniformity in systematic work: in the preparation of this bibliographical note the author expresses her indebtedness to Mr. C. Davies Sherborn.

The latter part of the catalogue is concerned with descriptions of Cretaceous thallophyta, in many instances accompanied by helpful illustrations. The author restricts the use of the generic name Algites, proposed in 1894 in a comprehensive sense for fossils which cannot be referred with any degree of certainty to a particular recent genus or family, to *flattened* impressions, and employs Sternberg's designation Chondrites for "algæ, or fossils which suggest algæ, with a much-branched dichotomous or sympodial thallus which is *cylindrical*." Having regard to the worthlessness, from the point of view of relationship to Chondrus, of most of the fossils referred to Chondrites, it would seem preferable to discard the name in favour of a general designation such as Algites if used in the wider sense in which it was first proposed. The concise summary of the characters of several types of algæ belonging to the Siphonaceæ and the Rhodophyceæ will serve to direct attention to the possibilities of a neglected branch of palæobotanical research. Among the fungi included in the catalogue the two most interesting are the Japanese species, *Pleosporites shirainus* and *Petrosphaeria japonica,* the former being represented both by perithecia and septate vegetative hyphæ.

Dr. Stopes carries into practice her suggestion (*Annals of Botany,* 1911) that "all fossil plants for which there is no good, scientific reason for association with given families and genera, and to which, nevertheless, names indicative of such affinities have been given, should be printed henceforth in Gothic characters." If this plan were adopted in the list of Cretaceous species in the first part of the volume as well as in the descriptive portion, very serious demands would be made on the printer's Gothic fount. It is doubtful whether this method will find favour: the use by palæobotanical writers of designations implying affinities that are assumed on wholly insufficient grounds seriously detracts from the value of published lists; but, it may be urged, the better course would be to discard the misleading names rather than to dignify them by the employment of Gothic letters. Moreover, this attempt to institute an *Index Expurgatorius* is based on an individual opinion and has not the sanction of supreme authority.

Dr Stopes has made an excellent beginning: the less interesting and more laborious work has been accomplished, and we confidently expect that the later volumes will add greatly to our knowledge of the vegetation of a period which is of exceptional importance. The flora of the preceding Wealden period is, in its general facies, a continuation of the Jurassic floras: flowering plants had undoubtedly been evolved, but they occupied a subordinate position and, so far as we know, were unrepresented in the Wealden flora of Britain. It was in the succeeding stages of the Cretaceous system that this remarkably successful group rapidly rose to the position of dominance that it now occupies in the floras of the world.

A. C. SEWARD.

ELECTROSTATICS AND MAGNETISM.

A Text-book of Physics. By Prof. J. H. Poynting and Sir J. J. Thomson. *Electricity and Magnetism.* Parts i. and ii. *Static Electricity and Magnetism.* Pp. xiv + 345. (London: Charles Griffin and Co., Ltd., 1914.) Price 10*s.* 6*d.*

THE late Prof. Poynting's qualities as a physicist are reflected in the volume on electrostatics and magnetism now before us, for he was always distinguished by soundness and clearness of thought, and care and accuracy of experiment rather than by showy brilliance. The book is very clearly written, and evidently no trouble was spared in the attempt to make it as easily understood as possible. A large part of it is, in fact, a model of exposition, and could scarcely be improved upon. The chief value of the book, however, lies in the fact that it goes a little farther than the ordinary elementary text-book has done up to the present. Most English text-books deal in a very cursory way with both electrostatics and magnetism, and it is extremely useful to have a book which gives a somewhat more adequate treatment without at the same time becoming too difficult and exhaustive.

The chapters on "The Dielectric," "Specific Inductive Capacity," "Stresses in the Dielectric," "Alterations in the Dielectric," and "Pyro-electricity and Piezo-electricity," are particularly good in the "Electrostatics"; and those on "Forces on Magnetised Bodies," "Paramagnetic and Diamagnetic Substances," and "Magnetism and Light" in the "Magnetism." The simple statement of the titles of these chapters will give a clue to the difference between this text-book and others. All the extra matter is quite important, and in no way abstruse, yet a considerable part of it is not to be found in any other English elementary text-book. The great value of the book to students is therefore obvious, and is scarcely lessened by the few defects which exist.

The first and most serious of the faults of the book is the inconsistency with which previous knowledge in the student is assumed. The first chapters in both the electrostatics and the magnetism are written as if for students with absolutely no previous knowledge of the subjects, while to understand the chapters on magnetic induction a student would require a reasonable knowledge of the magnetic field due to a current. In a book of this character it would seem that the most reasonable assumption to make is that the knowledge of the student is of about the intermediate science standard. The extremely elementary general accounts of the common phenomena could thus be omitted, and one could start without any preamble on the more important part of the book.

The order in which the various divisions of the subject are taken is rather strange in places. It seems the reversal of the proper order to give a number of the consequences of an inverse square law of force in one chapter and to give the experimental proof of the law in the following chapter, but the most flagrant case is the attempt to give a general account of susceptibility, permeability, and the hysteresis loop before any of the magnetic quantities have been defined. To an elementary student these things would be very confusing, but as there is no doubt that all students who come to this book will bring with them a fair working knowledge of the most elementary parts of the subject, very little harm will be done.

A few not unimportant matters of detail might also be improved. There are two totally different definitions of quantity of electricity, one on p. 29 and one on p. 67. It is true that these two are consistent with one another, but this is not proved, and the first definition is quite unnecessary and is nowhere used. The definition on p. 42 of the electric potential at a point as $\frac{\Sigma Q}{r}$ seems to be converting potential into a mathematical symbol with no direct physical meaning. If we define the difference of potential between two points as V when the work done in taking an indefinitely small quantity dq from one point to the other is $V.dq$, we not only have the physical conception of work per unit quantity but we can also define any other kind of potential in an exactly similar way.

It is also desirable that Franklin's jar with its movable coatings should be given a long-deserved rest. It does not prove, what it was originally supposed to prove, that the seat of electrical action is in the dielectric; it merely proves that glass is a very bad substance to use as an insulator, because it so readily forms a conducting layer on its surface by the absorption of moisture from the atmosphere. A Franklin's jar made with a good insulator does not work, and therefore there seem to be no reasons for introducing it.

Most of the diagrams are very clear and suitable; they are of good size and are simplified as much as possible. But Fig. 194 on p. 250 offends the eye of a physicist just as keenly as a note badly out of tune offends the ear of a musician. One scarcely expects all the diagrams of lines of force and equipotential surfaces to be drawn accurately to scale, but one does demand that lines of force and equipotential surfaces shall not be palpably inclined to one another as they are in this diagram. This certainly should be altered before a new edition is printed.

Although it takes a good deal of space to point out these defects, they are not numerous or important enough to decrease the value of the book sensibly. It is scarcely necessary to advise students to get the volume, as they will find it indispensable if they wish to obtain a good working knowledge of the fundamentals of electrostatics and magnetism. P. P.

BOTANY AND NATURE STUDY.

(1) *Introduction to Botany.* By J. Y. Bergen and Prof. O. W. Caldwell. Pp. vii + 368. (Boston and London: Ginn and Co., n.d.) Price 5*s*.

(2) *A Flora of Norfolk.* Edited by W. A. Nicholson. Pp. vii + 214 + 2 maps. (London: West, Newman and Co., 1914.) Price 6*s*.

(3) and (4) *Wild Flowers as They Grow.* Photographed in colour direct from nature by H. Essenhigh Corke. With descriptive text by G. Clarke Nuttall. Sixth series. Pp. viii + 200 + plates. Seventh series. Pp. viii + 204 + plates. (London: Cassell and Co., Ltd., 1914.) Price 5*s*. net each.

(5) *The English Year: Spring.* By W. B. Thomas and A. K. Collett. Pp. ix + 334 + plates. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 10*s*. 6*d*. net.

(6) *My Garden in Spring.* By E. A. Bowles. Pp. xx + 308 + plates. (London and Edinburgh: T. C. and E. C. Jack, 1914.) Price 5*s*. net.

(1) THE authors of this excellent elementary text are practised hands in the production of books on botany for students, and the present work is mainly a condensation of their larger work published a few years ago, entitled "Practical Botany," though from the abbreviated list of their works on the title-page one might infer that *each* author had published an earlier book with this name. However, it differs considerably in style from the authors' previous works, and indeed from most other elementary books on botany, in two features which are consistently kept in view throughout—namely, the emphasis which is laid on the dynamic side of botany, the plant being regarded as an organism forced to maintain its existence under conditions sometimes favourable and sometimes unfavourable to it, and the constant reference to the practical side of plant life in all its bearings. That is, while the work gives a good general grounding in botany, the ecological and the economic aspects of the subject, taken in the widest sense, are never lost sight of and at the same time are not unduly stressed. Since there are comparatively few references to plants unknown in the wild state or unfamiliar in cultivation in Britain, the book is one that can be warmly commended to teachers, at any rate to those who have no set syllabus to work from, while those responsible for the framing of syllabuses in elementary botany might learn much from a book like this as to what is wanted in the case of a subject with such marked educational significance. The book is generously illustrated, and the figures are remarkably clear and well executed.

(2) The Norfolk and Norwich Naturalists' Society is to be congratulated on the production of this admirable flora of a remarkably interesting county, a book which was certainly required, considering that the only previously published Flora appeared so far back as 1866 and has long been out of print. The editor of this work has left no stone unturned in his efforts to make the lists of the flowering plants and the higher flowerless plants of Norfolk as complete as possible, while he has enlisted the services of other writers in the earlier part of the book, dealing with climate, soils, physiography, and plant distribution, which precedes the plant lists. Both sections of the book are, however, open to a certain amount of criticism. While the articles on climate and on soils are all that could be desired, being admirably clear though brief, that on physiography and plant distribution is rather weak as regards the latter or vegetational aspect, though the part dealing with physiography is good so far as it goes. The author of what ought to be the most important portion of the general discussion of the flora of a county or other area fails to arrange his subject-matter clearly and logically, and his treatment of the ecology and distribution of the flora will, we fear, be useful neither to the average field botanist unfamiliar with the terminology or the ideas of modern ecological plant-geography, nor to the ecologist desiring to compare the vegetation of Norfolk with that of other parts of the country which have been systematically investigated from this point of view. In a flora of this kind, the general account of the vegetation should be preceded by an outline of general ecological principles, with an indication of the relations of the plant-communities represented in the area to the general scheme upon which these communities are based and classified. Again, in the systematic portion of the work, following on the flowering plants, we find the heading "Cryptogamia," but the list of flowerless plants stops short with the mosses and liverworts; either such a heading

should not be used, or the entire flora, including the lower cryptogams, should be dealt with.

(3, 4) Like the previous volumes with photographs in colour of British wild flowering-plants by Mr. Corke, and descriptions by Mr. Nuttall, these two series are extremely attractive books, though the text is, as before, less arresting than the plates, most of the latter being remarkably fine. The work is, however, intended for popular reading, and that it serves a useful purpose is shown by the mere fact that seven volumes, dealing with upwards of two hundred species, have now been issued. The number of the volume is indicated in each case by the curious device of a constellation of asterisks below the authors' names on the outside cover, but surely ordinary type would have been better than this. It is to be hoped that the authors will, in the further volumes of this series, include various flowering plants which, though devoid of conspicuous flowers and therefore less suitable perhaps for colour photographs, are of interest in other ways, as showing special adaptations of the vegetative organs for life in special habitats; if a few such plants were treated in each volume, the value of the latter for the drawing-room table would not be appreciably lessened, while their usefulness in other ways would be enhanced.

(5) The general get-up of this book, the post-impressionist style of a considerable proportion of text and coloured illustrations alike, and the extraordinary badness of the black-and-white figures, all combine to produce a loose, untidy effect which is evidently intentional, and intended for something very fine and striking, which somehow misses fire. The text is often sprightly and readable for a while, than one comes across pages of rhapsody and rubbish; sometimes we get really good observations and new points of view, but soon we are back to loose writing and absurd mistakes in the most elementary facts of plant and animal life. The book consists of a series of essays on a variety of topics more or less relating to the phenomena of springtime, and most of them give the impression of having been expanded, often by the interpolation of long bits of poetry, from articles written for the newspaper Press and kept within bounds by the exigencies of space in their original form. Much of the text is slovenly, will not bear parsing, to say nothing of scientific criticism; but probably it is only through careless proof-reading that the authors, after asking what are the most hackneyed lines on springtime, proceed to quote "Browning's 'O to be England,'" adding that "the lines are trite"—but any lines can be made less so when suitably treated.

(6) Here again the subject is spring, but with a difference. Mr. Bowles writes as one having authority on all gardening matters, and here he is perhaps at his best. He takes us through the kaleidoscopic pageant of spring in his garden, acting as guide, philosopher, and friend, dropping casually many valuable hints for those of his readers who would aspire to possess a garden with even a tithe of the rich collection he has brought together in his, and relating some amusing stories on the way. One of his chapter titles is somewhat startling—"The Lunatic Asylum"—and made us apprehensive of another excursion into very wild life, but after all it was only a piece of wild garden and the many and varied plants that were allowed to riot in it, so by way of "Tom Tiddler's Ground" we are brought back again into the Iris Walk, the Rock Garden, and so, with regret, to "The Culmination of Spring" and the end of a thoroughly delightful conducted tour.

F. C.

OUR BOOKSHELF.

Marine Engineering (a Text-book). By Engineer-Captain A. E. Tompkins. Fourth edition, revised and partly rewritten. Pp. viii+812. (London: Macmillan and Co., Ltd., 1914.) Price 15*s*. net.

DURING the six years which have elapsed since the publication of the third edition of this book, marine engineering has made great progress, and the author has taken the opportunity of bringing the present edition up to date. Thus we find new matter giving account of recent turbine practice, including the power transmission and speed-reduction devices of Parsons, Föttinger, and others. The sections dealing with the internal combustion engine are now fairly representative of modern practice, and contain descriptions of both two-stroke and four-stroke Diesel engines. A great deal of attention has been given to condenser plants during the past few years, and the author has not overlooked the work and experiments of Mr. D. B. Morison, Dr. Weighton, and Messrs. Weir. The section on the use of liquid fuel in boiler furnaces is also very complete.

The book is intended primarily for sea-going engineers, and there must be very many such who can bear testimony to the value of the previous editions, and who will welcome the book in its present form. The descriptions and drawings are exceptional for their clearness, and while the calculations given are of the simplest character, sufficient of the theory is stated in all cases to enable the engineer to have an intelligent understanding of the machinery under his charge. The sections dealing with care and management of boilers and machinery, and with the duties of the engineer of the watch, are very useful, and will be of service to other than marine engineers.

The Examination and Thermal Value of Fuel: Gaseous, Liquid, and Solid. By J. H. Coste and E. R. Andrews. Pp. xvi + 278. (London: C. Griffin and Co., Ltd., 1914.) Price 6*s.* net.

THE importance of the scientific examination of fuels and the avoidance of wasteful methods of utilisation is becoming more and more recognised as it is realised that economy, both individual and national, must be exercised in their application. This small treatise deals with the methods of sampling, analysis, and determination of the calorific value of fuels of all classes, and the examination of flue gases.

The book will prove of considerable service in the laboratory, but it must be confessed that in some sections it is lacking in that personal assistance, the result of experience, one is led to hope for in the preface.

In gas analysis, for example, many are the pitfalls besetting explosion analysis, but beyond the usual outline of procedure, little help is given in avoiding the difficulties. Again, whilst the Petroleum Act regulations for testing the flashing point of burning oil (which is of minor importance as a fuel) are quoted *in extenso*, the flash point of heavier oils (those of special importance as fuel oils) is dismissed with the briefest description of the Pensky-Martens apparatus, and no description of the method of working is given or reference made to the precautions necessary to obtain good results.

The sections on calorimetry are undoubtedly the most satisfactory portions of the book, with much evidence of personal experience. Very ample consideration is given to questions affecting the accuracy of the results and the comparative value of different types of calorimeters. Now that purchase on calorific value is becoming more general and legal standards of calorific value of gaseous fuels already established, the whole subject of calorimetry has become of primary importance, and this book is certainly a useful addition to the literature on the subject.

Rapid Methods for the Chemical Analysis of Special Steels, Steel-making Alloys, and Graphite. By C. M. Johnson. Second edition, rewritten. Pp. xi + 437. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 12*s.* 6*d.* net.

THE first appearance of this book dates back to 1908, and the edition now brought out contains quite twice as much material as its predecessor. The chapters have increased from sixteen to twenty-one, whilst the subdivisions of chapters, which were so strange in the first edition, are still further elaborated. The new chapters deal principally with the analysis of ores, refractory materials (acid and basic), fluorspar, lubricating oils, and coal; whilst uranium, cobalt and nitrogen are added to the section on steels. Besides these the chapter on the determination of carbon is amplified considerably, and an interesting account of the estimation of oxygen in tungsten powders and in steels has been inserted. The valuation of nickel chrome steels and Monel metal have been given chapters to themselves. Unfortunately, the new portions (which deal practically entirely with the author's own work—the general literature being rather neglected) have been inserted in such a way as to give the book a very patched appearance. The arrangement has also resulted in several rather tiring duplications. A blue pencil wielded by a friendly though very free hand would have tended to a much improved book. In a work of this nature one naturally looks for all things up to date, and in consequence one is surprised to find no appreciation of the "reductor methods" that are so extremely useful in analysis of this kind. Among many other omissions may be mentioned the work of Gooch and his pupils on vanadium, molybdenum, etc., the recognised volumetric methods for manganese in ferro-manganese, the ignition of Brünck's precipitate to nickel oxide, and the iodometric estimation of copper.

LESLIE AITCHISON

The Latest Light on Bible Lands. By P. S. P. Handcock. Second edition, revised. Pp. xii + 371. (London: S.P.C.K., 1914.) Price 6*s.* net.

ARCHÆOLOGY is a two-edged sword for those who would "prove the Bible," an uncertain lamp which may unexpectedly throw a distressing light on the mental calibre of chosen races; nay, more, traditions of similarities in Flood-narratives, or divergences in Creation-stories, may not unnaturally set up doubts in credulous minds as oppositions of science falsely so-called. It was one of the discoveries of Macalister at Gezer that Philistinism was a misnomer for boorishness, for the Philistines by the traces of their culture and civilisation there discovered have proved themselves to be far more worthy artists than the Hebrews. Mr. Handcock's book is of a kind which is published from time to time, giving the latest discoveries so far as they are analogous to the Old Testament, and recapitulating what was hitherto known. Here is again the Babylonian account of the Flood and the Creation of Man by Marduk from his own blood (why is no reference made to Mr. King, who first published the tablet containing the latter story?); an account of the Gilgamish epic and the Flood-story, told sufficiently accurately in their main points, although the distinction which the author makes in the epilogue is too nice for us ("'the gods came down to smell the sacrifice like flies,' a description which in its materialism contrasts somewhat strikingly with the dignified words of the Biblical writer, 'And the Lord smelled a sweet savour.'"); and a proper rejection of the Chedorlaomer theory. The chapters on the latest diggings in Palestine form a useful *précis* of what has been published by excavators, and Mr. Handcock gives also a full index of Old Testament place-names. In judicious hands his book will go far to provide a guard against one edge of the sword; it has been the writer's endeavour to allow the facts to speak for themselves.

R. C. T.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Age of a Herring.

THE very remarkable conclusions which Dr. Johan Hjort has drawn from his study of the scales of herrings are discussed, over well-known initials, in NATURE of August 27. Your contributor is evidently convinced of the truth of Dr. Hjort's deductions, and this opinion is shared, I believe, by very nearly all those biologists who make a study of fishery questions. Nevertheless, even in face of this general consensus of opinion, I am unable to persuade myself (on the evidence at present in hand) of the validity of Dr. Hjort's conclusions. The leading statements made by Dr. Hjort and his friends are these:—(1) That the age of each individual herring, or the year in which it was born, is at once made known by the number of rings upon its scales; (2) that, *ipso facto*, the shoal can be at once analysed into its component "year-classes"; and (3) that herring spawned in 1904 (according to such evidence) were so prodigiously numerous that year after year they have seemed to dominate the Norwegian herring-catch, and have constituted from 77 per cent. to 54 per cent. of all the Norwegian "spring herring" during at least the five years from 1910 to 1914.

To attempt to deal in a few words with all Dr. Hjort's careful work and laborious arguments is, of course, out of the question; but let me try to say as shortly as possible why I find it hard to follow him.

The whole argument depends on the primary assumption that the age of each herring is marked upon its scales, year for year, ring for ring. This is still a hypothesis. That there is no little circumstantial evidence in its favour I readily admit; but it has never been proved, and is only acceptable so long as the deductions to which it directly leads are themselves intrinsically acceptable.

Now if we sample at random a shoal of herrings, and analyse them acording to their scale-rings into so-called "year-groups," we find that these numbers range themselves with great apparent regularity in a unimodal skew-curve: just as the same fish group themselves also, according to size, in a unimodal but more normal curve. Here is one of Dr. Hjort's own samples, reduced to percentages as he himself gives it:—

"Age-groups," or Number of Scale-rings, in a Sample of 635 Herrings from the Dogger Bank (1910).

Number of rings	2	3	4	5	6	7	8	9	10	11	12	13
Presumed year of birth	1908	1907	1906	1905	1904	1903	1902	1901	1900	1899	1898	1897
Per cent. number of fish	0·2	8·4	14·2	21·3	18·9	14·3	9·3	5·7	5·5	1·3	0·8	0·3

Now, to say the least of it, it seems to me statistically improbable that a dozen separate generations of herrings, spawned in as many years, should have entered into the formation of the composite shoal in these curiously and regularly graded proportions. On the other hand, were we to assume that these herrings were *all of the same age and origin*, then we should have at hand an easy explanation of the facts, viz. that just as the individual herrings vary in a normal fashion about a certain modal size, so do they also vary, in the number of their scale-rings, about a certain modal number.

The rings on an oyster-shell are not just the same things as the rings on a herring's scale, but yet the analogy is not very remote. Miss A. L. Massy has lately made a study of oyster-shells, using oysters *of known age* from the hatchery at Ardfry. I extract from her data the following table:—

Analysis of a Sample of 341 Three year-old Oysters, according to the Number of Shell-rings.

Number of rings ...	2	3	4	5	6	7
Number of oysters ...	16	169	94	48	12	2

That is to say, in the case of the oyster the number of shell-rings does not correspond to the years of the oyster's age, but, on the contrary, is subject to variation according to regular and simple law. And the variability of the shell-rings in a sample of oysters all of identical age is in a very close degree similar to that of the scale-rings in a sample of herring drawn from one and the same shoal. The simple and crucial question is, then, whether in a shoal of herrings the evidence tends to show that all the fish are of one and the same age, like Miss Massy's oysters, or whether the shoal is a mixture of many generations, as Dr. Hjort asserts.

When we come to Dr. Hjort's final deduction, we find it illustrated, as your contributor tells us, by the following table, showing the manner in which successive "year-groups" of herring are said to have combined to constitute the Norwegian adult herring population of 1914:—

Spring Herring, 1914 (2205 *Fish Examined*).

Age (or number of scale rings)	Presumed date of Birth	Per cent. No. of fish
4 years	1910	0·6
5 ,, ...	1909	3·3
6 ,, ...	1908	6·9
7 ,, ...	1907	5·2
8 ,, ...	1906	7·2
9 ,, ...	1905	13·9
10 ,, ...	1904	54·3
11 ,, ...	1903	5·0
12 ,, ...	1902	1·5
13 ,, ...	1901	1·2
14 ,, ...	1900	0·4
15 ,, ...	1899	0·5

If we accept part of what this table sets forth, we must accept the whole. If we believe that the adult herring population consisted, to the extent of 54 per cent. of its total numbers, of herrings born in 1904, we must also believe that the remaining 46 per cent. was constituted of some eleven other successive yearly broods, all so nicely graded as to their proportionate amounts that these latter form an all but smooth curve, rising up to and falling away from the modal group of ten-year-old fish. Any normal population, as of men, consists, of course, of individuals of all ages, less and less numerous the greater their age. If there be, as among herrings there well may be, large and irregular fluctuations in the annual birth-rate, then the descending age-curve of the population would be irregular, one or more particular ages becoming unduly prominent. But that is a totally different thing from the population-curve which Dr. Hjort presents to us. He tells us that the 1904 group was, and has remained, so predominantly abundant as to constitute for several successive years from one-half to more than three-fourths of the whole stock of adult herrings; not merely that that year-group was more abundant than any one of its immediate successors or predecessors, but that it outnumbered all its contemporaries, both older and younger, put together; and that this continued year after year, though all the while the great herring fishery was mainly supplied by drafts upon that identical and unfailing brood. That there are fluctuations in the abundance of fish, herring and others, is well enough known; that there are good spawning years and bad, or good and bad years for the survival and growth of the young, is also certain. But an increase of birth-rate or a diminution of natural mortality such as would cause the race of ten-year-old herring to outnumber all the rest put together, from four years old to fifteen, is very hard indeed to imagine.

Here, as it seems to me, is a clear case of a biological problem, based upon statistics, surrounded by mathematical difficulties, where the biologist cannot possibly be sure of his ground until he has enlisted the help of the mathematical statistician.

D'ARCY W. THOMPSON.

The Red Flash.

THE interesting recent letter (NATURE, vol. xciii. p. 664) on the green flash leads me to send a brief note on a much rarer correlative phenomenon, also, of course, due to atmospheric dispersion, viz., the red flash.

Let there be a cloud low down, with a well-defined lower edge, separated from the actual horizon by an interval of clear sky. Then, at the lower edge of the cloud, just as the base of the setting sun reappears, or that of the rising sun disappears, the red flash may be seen.

I have observed the green flash, connected with the top of the sun, scores of times; but the red flash, connected with its base, only about thrice, as the conditions are obviously much less frequently fulfilled.

I venture to think that "flash" is a more suitable term than "ray," for the latter may lead people to suppose that a long streamer of light is to be expected. I last saw the red flash at Clapham (Yorkshire) on September 11, 1913, at 6.30 p.m. It was preceded by a green flash at the upper edge of the cloud.

It may be well to add that, even when all circumstances seem to be apparently favourable, no flash (either green or red) may be visible. My own experience, now a long one, is that failure is decidedly more frequent than success.

C. T. WHITMELL.

Invermay, Hyde Park, Leeds, September 6.

OPENINGS FOR BRITISH CHEMICAL MANUFACTURERS.

AS a result of the state of war between this country and Germany and Austria an unprecedented opportunity has arisen of making a firm endeavour to establish the manufacture of a very large number of chemicals which have hitherto been produced mostly abroad.

It is a mistake to think, as many people do, that most of these are patented articles; on the contrary, the vast majority are very well-known products in considerable demand, and these ought first to receive the attention of the English manufacturer.

It is very desirable, however, and no doubt this course is being largely pursued, that existing manufacturers should endeavour to extend their energies to the production of materials of a similar character to those which they already make, and not to enter an unknown field of manufacture unless they feel very sure of their ground. We have, in this country, the nucleus of a vast chemical industry embracing all, or very nearly all, the ramifications that have been so exhaustively extended by the large German chemical works, and now is the time for that nucleus to expand in a natural way until all our requirements and those of our colonies, our allies, and the neutral States can be fulfilled.

This is a point that requires insistence, as there is considerable danger of manufacturers rushing into the production of materials, hitherto bought from abroad, and only incidentally used in their own business, which in many cases have already been made here, or which, on application to the maker of allied substances, could be produced by him with a minimum expenditure of money and labour. Thus the soap-boiler who has formerly purchased foreign synthetic perfumes, the perfume maker who has bought aniline dyes, the aniline dye manufacturer who has had to depend on Germany for his raw materials, all should apply to existing English manufacturers of their requirements before embarking upon the production of materials foreign to their manufacturing experience. The writer has experienced several cases of manufacturers proposing to prepare chemicals which they imagine have been entirely made in Germany, who have been surprised when informed that such are produced in large quantities in this country.

At the same time, however, there is undoubtedly a great opportunity for starting new manufactures in various directions, but the products to be considered first should be of as simple a nature as possible, especially in the case of organic substances, for the successful manufacture of many of the more complicated of these can only, in most cases, be attained after several years' work.

As regards those articles which are patented or protected by a trade mark the Board of Trade has made rules (Patents, Designs, and Trade Marks (Temporary) Rules, August 21, 1914), under which a German or Austrian patent may be entirely suspended, so that there need be no difficulty in obtaining permission to manufacture according to such patents, and, indeed a large number of applications to this end have already been received at the Patent Office.

Further, it may be stated that, although various organic substances can only be made with the use of ethyl or methyl alcohol, methylated spirits not being suitable, the regulations with regard to these under the Finance Act of 1902 make it possible to use them in manufacture in a convenient manner, and it is for the would-be user to suggest to the Commissioners of Customs and Excise the means by which it is proposed to make the spirits unpotable. This object is obviously easily attained by using either the raw material or the finished product as the "denaturant."

Of the actual chemicals for which there is a demand now owing to the stoppage of imports from the continent, perhaps potassium salts take the first place, as the Stassfurt deposits have, for a considerable time, been their chief sources. Other sources of potassium salts, however, exist in the nitre found in India and in the kelp of the West Highlands, and it seems feasible to suggest that the latter industry should be taken up again, as it furnishes not only potassium salts but also iodine (compare in this connection W. R. Scott, Report to the Board of Agriculture on the kelp industry in the West Highlands, Blue Book, Cd. 7564).

It must not be forgotten that in many cases sodium salts can be used instead of potassium; thus the bromide, chlorate, dichromate, and permanganate of sodium might be manufactured instead of the potassium salts. In this connection it may be as well to point out that there must be a large amount of potassium salts stored in the various universities and technical schools of this country which might be collected, and, where necessary, worked up for the supply of those salts which are needed now for medicinal purposes in hospitals, etc., until a further supply becomes available. The ordinary employment of potassium salts in the laboratory can easily be avoided by the use of sodium salts in almost every case.

An important industry is that of the manufacture of thorium nitrate, which is used so largely for incandescent mantles. Although this compound is already made in England, the supply is not equal to the demand, and there ought to be little difficulty in diverting the chief source, viz., monazite sand, from Brazil to this country.

The manufacture of the large amount of glass chemical apparatus and other articles, such as cylinders for incandescent lamps, hitherto made from the so-called "Jena-glass"—a borosilicate glass containing zinc and barium oxides—ought certainly to be taken up by English glass makers, and the Potteries should seriously consider the question of supplying Berlin porcelain.

Turning now to the organic side of chemical industry there is a very considerable demand for formic acid and formaldehyde and its derivatives used in medicine, such as hexamethylenetetramine (urotropine), but of all organic medicinal drugs perhaps the greatest shortage is in salicylic acid, which is required also in the preparation of certain dyestuffs. Hitherto the world's supply has been provided by a large German works, and the manufacture of such an important substance in this country is very necessary. Provided with this the production of such drugs as salol (the phenyl ester) and aspirin (the acetyl derivatives) is rendered possible. Other acids, such as benzoic, citric, and tartaric, are also needed.

Of other well-known drugs the manufacture of acetanilide and phenolphthalein is easy, whilst that of phenacetin (acetyl-*p*-phenetidine), atophan (2-quinoline-4-carboxylic acid), antipyrine (phenazone), and its various derivatives, sulphonal and its congeners, veronal, the various guaiacol compounds, and the organic arsenic derivatives, such as atoxyl and salvarsan, is more difficult.

Closely allied to many of the above, from the manufacturing point of view, is the large class of photographic developers, amongst which may be mentioned pyrogallol, hydroquinone, and metol (methyl-*p*-aminophenol sulphate), and synthetic perfumes, such as vanillin, artificial musk, ionone, heliotropine, etc.

Efforts will no doubt be made to produce in England the great quantity of organic dyestuffs hitherto imported from Germany. A considerable number has also been provided by Switzerland, and presumably this importation will continue. A large amount of azo-, nitro-, alizarin, and sulphur dyes has been produced for a long time in England, as well as indulines, magenta, aniline blues, methylene blue, etc., and no doubt the manufacture of these is being largely increased, but there is a great field open to the British manufacturer in the case of vat dyes, such as indanthrene, and its derivatives, of which the raw material is already made here, and synthetic indigo and its derivatives, including thioindigo.

J. C. CAIN.

NOTES.

WE regret to see the announcement of the death, at sixty-six years of age, of Dr. W. H. Gaskell, F.R.S., University lecturer in physiology, Cambridge.

THE *Morning Post* announces that the Huxley Memorial Lecture at Charing Cross Hospital on recent advances in science and their bearing on medicine and surgery, by Sir Ronald Ross, originally fixed for October 1, has been postponed to Monday, November 2.

THE death is announced of Mr. H. M. Freear, chemical assistant at the Woburn Experimental Farm and Pot-culture Station of the Royal Agricultural Society, and a leading authority upon the relation of pot-culture experiments to practical agriculture and horticulture.

MR. EDWARD RILEY, whose death is announced, at eighty-three years of age, was early associated with the production of Bessemer steel at the Dowlais Iron Works in South Wales, where he was chemist from 1853 to 1859. At the May meeting of the Iron and Steel Institute this year, he was awarded the Bessemer gold medal in recognition of his work in analytical chemistry and metallurgy.

AN announcement was made in NATURE of June 18 (p. 415) to the effect that Mr. Thomas Cawthron, of Nelson, New Zealand, had made a gift of 50,000*l.* for a beginning for a solar observatory to be erected in New Zealand. Miss Mary Proctor asks us to state that the amount is "30,000*l.* for a beginning," and that she is responsible for the conflicting statements which have been made, as she was "under the mistaken impression that the amount was 50,000*l.*, and made a statement to that effect without being duly authorised."

THE death is announced, on September 8, at seventy-four years of age, of Mr. William Erasmus Darwin, eldest son of Charles Darwin. It was with reference to this son that Darwin wrote in his autobiography:—"My first child was born on December 27, 1839, and

I at once commenced to make notes on the first dawn of the various expressions which he exhibited, for I felt convinced, even at this early period, that the most complex and fine shades of expression must all have had a gradual and natural origin." These notes provided a natural explanation of phenomena which appeared to be a difficulty in the way of the acceptance of organic evolution, and they formed the basis of the volume, "Expression of the Emotions in Man and Animals," published in 1872.

FROM Göttingen the news is announced of the death of Prof. Wilhelm Lexis, the economist, whose name is well known to students in connection with the "Handwörterbuch der Staatswissenschaften." Lexis was born on July 17, 1837; matriculated at Bonn in 1855, reading there mathematics and natural science. After graduating he was an assistant master at Bonn until 1861, when he went to Paris to study French economic conditions. Very soon he became known as an authority on economic problems, and in 1872 he was appointed to the chair of political economy at Strassburg. Two years later he was called to Dorpat; thence in 1876 he went to Freiburg, where he remained eight years. In 1884 he moved to Breslau, and in 1887 to Göttingen. Here he taught economics for twenty-five years, retiring in 1912 with a reputation that was world-wide.

SINCE the discovery of well-preserved skeletons of ancestral horses in the Eocene formations of North America, palæontologists have been anxious to compare the skulls of these specimens with one from the London Clay of Harwich, which was described by Owen in 1858 under the name of *Pliolophus vulpiceps*. This fossil, in association with various limb-bones of the same animal, was obtained by the Vicar of Harwich at that time, the Rev. Richard Bull, who gave portions of the upper and lower jaws and some fragments of limb-bones to the British Museum, but retained the greater part of the specimen. Since then it has been lost to science, but it now appears that all the associated remains have been carefully preserved by the widow of the discoverer exactly as he left them, and they have just been presented by Mrs. Richard Bull to the Geological Department of the British Museum (Natural History). The skull of Pliolophus, which still remains unique, is thus again accessible for study and comparison. As pointed out by Mr. R. Lydekker, it is probably referable to a species of Hyracotherium.

THE Smithsonian Institution has issued a treatise on atmospheric air and its relation to tuberculosis, by Dr. Guy Hinsdale, one of the prize essays presented in connection with the Washington Tuberculosis Congress (Publication No. 2254, Smithsonian Miscellaneous Collections). The author does not claim that there is any specific climate for tuberculosis. Of first importance are chemically and bacteriologically pure air and sunshine. One thing to be avoided is a climate in which the humidity varies greatly. Probably the best combination is a low humidity and a moderately cool temperature.

THE Local Government Board has issued a supplement containing a third report on infant mortality dealing with infant mortality in Lancashire, by the medical officer of the Board (Dr. Newsholme), and Drs. Copeman, Manby, Farrar, and Lane-Claypon. This county contains nearly one-seventh of the total population of England and Wales, and it suffers from a rate of infant mortality which is equalled in few other parts of the country. The evidence suggests that the most important factors conducing to this are (1) the continuance of unsatisfactory methods of dealing with excremental and domestic refuse; (2) unsatisfactory conditions of housing; (3) the industrial employment of married women during pregnancy and confinement; (4) a relatively low standard of life, especially among the miners.

To the current number of the *Psychological Review* Mr. W. S. Hunter contributes a paper on the after-effects of seen movement, in which several new observations are recorded. He finds that if the original movement be observed by one eye, and if a stationary surface be afterwards viewed by the resting eye, a faint, but distinct, after-movement is noticeable. This after-effect, however, occurs only when the moving field first regarded consists of parallel lines; it does not occur in the case of a rotating spiral. The writer attributes the illusion in the resting eye to eye-muscle strains arising from inhibition of the reflex tendency to follow moving lines; in conformity with which view he finds that in the case of parallel lines the after-effects are reduced or abolished when the eyes adopt a position of strain. He also notes that the illusion can, in part, be successfully controlled by the subject, and hence concludes that in the case of parallel lines the after-movement is determined by "associative factors" and eye-strain, in addition to the retinal changes which, in the case of the rotating spiral, alone play an important part.

IN the Journal of the Gypsy Lore Society (vol. vii., part iii.) the latest theory of the Indian origin of the Gypsies, that of Prof. A. C. Woolner, is discussed. He arrives at the conclusion that the theory of their origin from the Jats is unsupported by philology, and is opposed by the fundamental differences between the characters of the typical Gypsy and the typical Jat. Their connection with the Kafirs of the Hindu Kush is equally improbable. The physique of the modern Dom is very different from that of the present Gypsy, but both types may have been modified by environment and by intermixture with other tribes. Something is to be said for the view of Mr. H. L. Williams (Journal Gypsy Lore Society, vol. v.), who connects them with the Sansiyas and other criminal nomads of Northern India. On the whole, Prof. Woolner's view that the Indian element in Romani is not homogeneous, and that when this type of speech left Indian soil it already contained elements picked up in different parts of that area. In other words, the Gypsies were originally wanderers, and then, as now, picked up in their wanderings unconsidered trifles in the shape of words and grammatical forms. This seems to be a reasonable view, and the evidence appears to point to a migration of the nucleus of the race from south-east India to the north-west, whence they passed westward from the neighbourhood of Peshawar.

THE seventh annual report of the American Bison Society contains two very satisfactory items—first, that the number of pure-bred bison living in the country at the end of 1913 (inclusive of the 549 calves born the same year) was no fewer than 3788, and, secondly, that the society has decided to include within the scope of its aims the protection of the prongbuck, a species now standing in urgent need of such assistance. It should be added that there is a discrepancy in regard to the number of living bison in different parts of the report, the number given in the president's address being 3453, and that in the summary by the secretary the figure quoted above.

THE imperfections of our seismic records are most noticeable during the periods of great European wars. Accounts of recent earthquakes are, of necessity, rare or brief at the present time; but, in neutral countries, seismological inquiries are being carried on as usual. The weekly bulletins of the Hawaiian volcanic observatory, for instance, record the changes that occur from day to day in its neighbourhood. In the last number (No. 27) Mr. H. O. Wood reports on the earthquakes registered in the Whitney Laboratory of Seismology at Halemaumau from April 21 to July 22, 1914. During these three months sixty-one local shocks were registered, of which only five were perceptible without instrumental aid. The number of shocks is thus at present small for a volcanic centre, but a considerable increase in their frequency will no doubt herald any important outburst.

THE earthquakes of Norway have recently been studied in detail by Mr. C. F. Kolderup (Bergens Museums Aarbok, 1913, pp. 1–152). He gives first a list of the more important earthquakes from 1612 to 1886. After the latter year, the chronicle becomes much more complete. During the twenty-five years 1887–1911, the number recorded is 494, that is, at the rate of nearly twenty a year. In Great Britain the average annual number of earthquakes is twelve; so that, taking area into account, the frequency of earthquakes in the two countries is the same. The Norwegian earthquakes appear, however, to be of greater strength, six having disturbed areas of more than 50,000 square miles, the corresponding number for Great Britain being three. Again, the strongest Norwegian earthquake (that of October 23, 1904) disturbed an area of 367,000 square miles; while the strongest British earthquake (that of December 17, 1896) disturbed 98,000 square miles. In both countries the earthquakes are most frequent during the winter months; and, throughout the day, are most perceptible during the hours 10–11 p.m. and 1–2 a.m.

THE limited literature on iridium in its mineral forms is enriched by Bulletin 17 of the Geological Survey of Tasmania (John Vail, Hobart, 1914), by W. H. Twelvetrees, on "The Bald Hill Osmiridium Field." The mineral occurs here as granules, with magnetite, chromite, nickeliferous pyrrhotine, and gold, in an altered peridotite, and is mostly won from alluvium. From the interesting review of the occurrence and use of iridium in the world at large, we gather that a certain mystery overhangs the trade, since the tipping of nibs for fountain-pens, and the production of hard ends for other apparatus, scarcely account for the increased demand for osmiridium.

RECENT publications of the Geological Survey of the Department of Mines, Tasmania, are concerned with interesting mining areas. Bulletin 14, on "The Middlesex and Mount Claude Mining Field," and 15, on "The Stanley River Tin Field," describe the tin ores that were introduced into metamorphosed pre-Cambrian sediments by the uprise of granite in Devonian times. L. L. Waterhouse concludes that the banded ore-deposits of the Stanley River represent an actual replacement of the original country-rock, the structures of which are often preserved, even in the sulphide-ores. Bulletin 16, on "The Jukes-Darwin Mining Field," contains views of the forest-clad foothills and the great ridges of schist and granite east of Macquarie Harbour. The topography has been notably modified by glacial action.

THE Australian Geological Surveys materially assist in the development of the resources of the country. Since the work that was noticed in NATURE, vol. xciii., p. 307 (May 21, 1914), we have received several publications dealing with mineral deposits. E. C. Saint-Smith and R. A. Farquharson describe the Southern Cross area of the Yilgarn Goldfields (Geol. Surv. W. Australia, Bull. 49), where quartz-reefs occur in a complex country, which includes banded jaspers that may be of sedimentary origin. The most important reefs from an economic point of view occur as metasomatic replacements of schists along shear-zones, while those in the granite from which the siliceous infiltrations spread bear very little gold. The northern part of Kalgoorlie is described in Bulletin 51, and here the ferruginous jaspers, which have so wide an interest among the old rocks of both hemispheres, become in part graphitic as they approach deposits of sulphide ores.

IT has been established by persistent statistical researches that the south-west monsoon rainfall in India is affected by various previous conditions in or outside that area, and seasonal forecasts based thereon have been made with more or less success since 1882. In a recent paper, entitled "A Further Study of Relationships with Indian Monsoon Rainfall" (Memoirs, vol. xxi., part viii.), Dr. Walker discusses at considerable length several correlations from all available data, but the results of this useful investigation have mostly proved to be of a negative character. (*a*) *Relationship with previous barometric pressure in India*: There is a tendency for the pressure of any year to be high when the monsoon is deficient, and *vice versâ*, but the indications do not seem to be of much practical use in forecasting the character of the monsoon a few months before its arrival. (*b*) *Relation with previous Indian temperature*: It is generally admitted that the monsoon rainfall is connected with the replacement of heated air by damper air from the ocean, and that years of high temperature in May should be years of good rainfall, but it is shown that this is not the case. Dr. Walker thinks that improved knowledge of conditions in the upper air will eventually throw light upon the matter. (*c*) *Effect of icebergs in the Southern Ocean*: From an examination of the Meteorological Office tables of icebergs published in the Monthly Meteorological Charts of the Indian Ocean, separately tabulated for each ocean, by Dr. Shaw's direction, it does not appear that the icebergs of the Indian Ocean have any material effect. The data for the South Atlantic appear to be more promising, but no definite conclusion can yet be formed.

THE Indian Association for the Cultivation of Science has republished, as Bulletin No. 10, under the title, "Optical Theories: a Brief Historical Survey," the address delivered by Prof. Mallik at the annual meeting in November last. In sixteen pages the author sketches the development of scientific ideas as to the nature of light from those of the early Greek philosophers to the modern view, according to which it is an electromagnetic phenomenon taking place in an æther through which are distributed singularities of a simple kind known as electrons and of a complex kind known as matter. He shows that at the time the Greeks were discussing the rival theories of Pythagoras, that light consisted of particles projected from luminous bodies to the eye, and of Empedocles, who held that for vision a so-called "visual influence" was necessary in addition, the Indian philosophers were discussing the problem on almost identical lines.

IN Mr. F. W. Lanchester's second article in *Engineering* for September 11, on aircraft in warfare, it is stated that the weaknesses of the dirigible on the defensive are so great and of such a character as to render it quite unfit to remain an active participant in aerial warfare. It may escape for a time, and may render a certain amount of useful service, but only thanks to the circumstance that the number of high-powered, fast-climbing aeroplanes is comparatively limited, and to the fact that scientific methods of attack have not yet been fully worked out or put into practice. However, even to-day the finest of Germany's fleet of Zeppelins would be absolutely at the mercy of a modern aeroplane in the hands of a man prepared to make his one and last sacrifice. So fragile and combustible a contrivance as a dirigible, whether rigid or non-rigid, can never, in Mr. Lanchester's opinion, survive in the face of the rapid development of the modern aeroplane and the engines of offence with which before long it will be furnished.

SOME interesting notes on the relation of rainfall and yield are contributed by Mr. D. Halton Thomson to *Engineering* for September 4. If the annual yield for a given drainage area be plotted against the rainfall for the corresponding period, the points generally are distributed in a haphazard manner, and there is difficulty in drawing a simple curve—usually assumed to be a straight line. The irregularities may be due to inaccurate observations, the varying physical conditions of the drainage area from year to year, and to the fact that the yield lags behind the rainfall. If twenty or more consecutive annual observations are available, the author suggests that the two phenomena may be correlated on the assumption that the rainfall of a given frequency produces a yield of the same frequency. Time-lag and difference of time-distribution may be eliminated by this means. The author derives a formula on this assumption for the Redmires drainage area of the Sheffield Waterworks, and finds $Y=R-14$, Y being the annual yield and R the annual rainfall, both in inches. The formula for the Trenchford drainage area of the Torquay Waterworks is $Y=0{\cdot}9R-13$. In the first case the annual evaporation is 14 in., whatever the rainfall, and in the second case the annual evaporation increases slightly with the rainfall.

THE *Engineer* for September 4 has an article dealing with the problem of pitwood supplies, the dearth of which, brought about by the war, is becoming a matter for serious consideration by colliery companies. Northern Russia, whence important cargoes have been usually shipped, is no longer able to keep up the supply, and scarcity of labour in south-west France has resulted in the suspension of cutting and transporting; shipments from Norway and Sweden are at present impracticable. It seems that only one alternative is to be found if the dearth of pitwood becomes extreme. To most collieries the permanent use of steel would be too expensive. It has been suggested that scrap tubes and rails, cut to suitable lengths, would make good substitutes for pit timber. A midland colliery has used for some time props made from old steel pipes; these are filled with soft and hard wood, the pipes forming a strengthener to the wood portion. This composite prop is lighter and stronger than the ordinary wood prop, is adjustable in length, and by its soft ends gives good warning of a collapse. Our contemporary suggests that the filling in of worked out parts of mines with sand, ash, slag, etc., would lead, among other important advantages, to a diminished demand for timber for pit purposes.

OUR ASTRONOMICAL COLUMN.

COMET 1913*f* (DELAVAN).—Delavan's comet is gradually moving westward among the stars; while it is now best observed in the early morning, it will, towards the end of the month, be an evening object for observation as well. The ephemeris given in this column last week is quite sufficient for anyone to detect this naked-eye object. Those possessing clock-driven equatorials can do useful work by strapping small cameras on to the telescope tube for the photography of the tail. During the evening of September 14 the comet was seen to have brightened very considerably, and was a conspicuous object to the naked eye. It was situated towards the west of θ Ursæ Majoris (3·2 mag.), but a more correct position would be to the west of 31 Ursæ Majoris, and close to this star. In fact, 31 Ursæ Majoris was involved in the tail. The nucleus closely approximated in brightness to ν Ursæ Majoris, a fourth magnitude star.

FURTHER NEWS OF ECLIPSE PARTIES.—The current number of the *Observatory* (September) publishes several items of interest about the parties which went out for the eclipse. It is stated that no news has come to hand about the Cambridge Solar Physics Observatory party, but that Mr. Stratton had been previously recalled for military service, and arrived in England on August 23. Major Hills and Prof. Fowler describe briefly the attempt to reach their observing station at Kiev (Russia); they only got so far as Riga, and had to return. According to the *Morning Post* (September 7) the Russian astronomers were disappointed at the fact that Major Hills and Prof. Fowler when at Riga did not communicate with Prof. Backlund, because a Russian eclipse expedition went to Riga prepared to assist them in every way. As it happened, the weather at Riga was much finer than at most of the eclipse stations. The *Morning Post* gives further information about the German astronomers, who were invited to Russia to observe the eclipse. It seems that the German parties were warned in time to return, and some did so. Those who hesitated were arrested and sent to Odessa. It is then stated, "The American party packed up the German instruments and sent them also to Odessa, but nothing has been heard of them since, and the German astronomers have been vainly appealing to Prof. Backlund, who is naturally helpless and cannot interfere personally."

VERTICAL CIRCLE OBSERVATIONS AT THE U.S. NAVAL OBSERVATORY.—Vol. viii. (second series) of the Publication of the United States Naval Observatory contains the vertical circle observations made with the 5-in altazimuth instrument for the period 1898 to 1907. The observations were made by Messrs. F. B. Littell, G. A. Hill, and H. B. Evans, and were reduced by the first-named. The volume is subdivided into introduction, observations and reductions, individual results of observations and catalogue. The introduction contains an account of the instrument, which was built by Messrs. Warner and Swasey, under the supervision of Prof. William Harkness; it was completed and housed at the end of 1897, and first used in February, 1898. The aperture of the telescope is 5·02 in., and the focal length is 50 in. Two sections and a photograph of the instrument *in situ* illustrate the general arrangements. Pp. 1–389 show the observations and reductions; pp. 393–445 are devoted to the individual results of the observations; and pp. 447–65 give the catalogue. In the last-mentioned the magnitudes are those of the Revised Harvard Catalogue. The declinations are derived from the means of the individual results by the application of the corrections for flexure and latitude; they are for the epoch given in the column headed "Mean Date," and for the mean equator 1900·0. The precessions and secular variations are based on Newcomb's constants.

PARALLAXES OF THE BRIGHTER GALACTIC HELIUM STARS.—No. 82 of the Contributions from the Mount Wilson Solar Observatory, reprinted from the *Astrophysical Journal*, vol. xl., 1914, July, contains an extensive and important research by Prof. J. C. Kapteyn, entitled "On the individual parallaxes of the brighter galactic helium stars in the southern hemisphere together with considerations of the parallax of stars in general." The communication covers eighty-six pages, and is divided into twenty sections, the first being composed of an introduction and a summary. The stars chosen are the helium stars brighter than the 6th magnitude for the part of the sky lying between galactic latitudes ±30°, and galactic longitudes 216°–360°. In a subsequent paper or papers, he hopes to deal with the helium stars in the other parts of the sky. For the brighter stars of other spectral classes he has not attempted to derive individual parallaxes, but has discussed the prospects of the successful treatment of such an investigation. The reader must be referred to the paper itself for the details and results of the investigation, but attention may be directed here to the very interesting charts dealing with the distribution of the helium stars as regards galactic positions illustrating the apparent tendency of these stars to clustering. The most extensive of these clusters is between longitudes 200° and 340°, and this group forms the main subject of the present paper. Another chart gives the arrangement of the helium stars in space. Prof. Kapteyn directs particular attention to three fairly strong condensations with different parallaxes, and he says: "Of course, we may see in the arrangement of these condensations the indication of a spiral structure. I shall not lay much stress on this, unless we find the same thing repeated in other parts of the sky."

PAPERS ON INVERTEBRATES.

THE anatomy of the blind prawn of the Sea of Galilee (Lake of Tiberias), described by Dr. Calman in 1909 as the representative of a peculiar genus, under the name of *Typhlocaris galilea*, is discussed by Mr. Ghosh in vol. ix., No. 6, of the Journal and Proceedings of the Asiatic Society of Bengal. In another article in the same issue Messrs. Annandale and Kemp point out that, so far as known, the Sea of Galilee is the home of only three species of decapod crustaceans, of which the aforesaid Typhlocaris is noticeable on account of its marked structural differences from all other members of the group, as well as for its apparent modification for subterranean existence. As a matter of fact, it is known from a single open and well-lighted pool near the marge of the lake, and the authors suggest that earth-movements may have been the cause of this departure from its apparently proper habitat.

In the April number of the Records of the Indian Museum, Mr. Kemp continues his notes on the decapod crustaceans in the Indian Museum, dealing in this instance with the family Hippolytidæ, a group notable on account of the great generic variation in bodily form and in secondary sexual characters. Several species and two genera are described as new.

New and other African scorpions, spiders, etc., form the subject of an article by Mr. J. Hewitt in vol. iii., part 1, of Records of the Albany Museum. It is noteworthy that a two-lunged spider, *Cydrela friedlanderi*, of the family Zodariidæ, resembles the members of a totally different group in closing the entrance to its burrow by means of a trap-door. In the two-lunged trap-door species the females are bright-coloured like their allies, which do not protect themselves in the same manner; in other trap-door spiders, on the contrary, the females lack bright colours.

Two infusorians of the family Cothurnidæ found in moss during Dr. Charcot's Antarctic expedition led Mr. E. Penard to undertake a re-investigation of moss-dwelling rhizopods and infusorians, the first result of which is an elaborate article on the Cothurnidæ communicated by that naturalist to the *Mém. Soc. Phys. et Hist. Nat. Genève* (vol. xxxviii., fasc. 1). These organisms form an important feature of the invertebrate life of the polar regions, where moss and lichens constitute the chief vegetation; they are, however, by no means restricted to high latitudes, and the author has devoted much attention to the question whether in warmer zones they may not pass part of their time in open water. His answer is that while some are exclusively moss-dwellers, others appear to spend weeks, if not months, periodically in water.

Among the contents of the first *livraison* of vol. xlv. of *Trav. Soc. Imp. Nat., St. Pétersbourg.*, is an article on the anatomy and physiology of the synaptid holothurians, to which a brief abstract in French is appended.

We have been favoured with copies of three papers contributed by Mr. E. W. Adair to the *Bull. Soc. Entom. d'Egypte* for 1912 and 1913, published 1914. In the first (1912) of two relating to the life-histories of the insects of the family Mantidæ it is pointed out that the supposed additional metamorphic stage recorded by Pagenstecher in the case of *Mantis religiosa* was due to the newly emancipated imago being enveloped in the amnion of the ovum. In the third paper the author records "jumping seeds" of *Tamarix nilotica*, the movements of which were produced by imprisoned larvæ of a small weevil, *Nanophyes maculatus*. Hitherto similar movements have been known only in the case of the Mexican so-called "jumping beans," of which the moving power are the larvæ of certain tortricid moths, especially *Carposapsa saltitans*.

In an article contributed to vol. iv. (new series), part i., of the Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, Mr. R. S. Bagnall states that whereas a few years ago only a single representative of the centipedes of the group Symphyla was known from the British Isles, he had been enabled to raise the number to no fewer than twelve species and one subspecies, five of the former, of which three are described as new, belonging to the genus Scutigerella, and the remaining seven, of which six are new, together with the subspecies (also new) to Scolopendra. In a supplemental article published near the end of the same issue he describes a seventh new species of Scolopendra, from Cheshire, and raises the aforesaid subspecies to specific rank, thus recording a total of fourteen British species, of which, however, one Scutigerella has hitherto been detected only in hot-houses.

In No. 1 of vol. v. of the Entomological Series of the Memoirs of the Department of Agriculture, Mr. C. C. Ghosh continues his life-histories of Indian insects, dealing in this instance with eleven species of butterflies, inclusive of the common British cabbage-white. The account of the rice-leaf caterpillar, and its butterfly, so injurious to rice-crops all over the Old World and Australia, is from MS. left by Mr. Maxwell-Lefroy, when Government entomologist. The nine coloured plates are admirably executed.

Fuller acquaintance with the insect-fauna of the eastern and north-eastern districts of the Transvaal and southern Rhodesia has enabled Dr. L. Péringuey to add considerably to the list of South African representatives of the hymenopterous family Mutillidæ. His first article on the subject was contributed to vol. i. of the *Annals of the S. African Museum* (1898): his latest forms part 15 of vol. x. of the same serial (1914).

Beetles of various families, inclusive of the Tenebrionidæ, Cetoniidæ, and Buprestidæ, collected during the Duke of Mecklenburg's travels, form the subject of articles by various specialists in Lief. 3 of the first volume of the Zoological section of *Ergebnisse der Zweiten - Deutschen Zentral - Afrika - Expedition*, 1910–1911. Many new species are named, and it may be well to note that the name of the Ubangi Valley has been adopted as a generic designation, "Ubangia."

An extensive collection of brittle-stars, or ophiurids, from the Caribbean Sea in the U.S. National Museum has enabled Prof. René Koeler not only to describe a number of new species, but, what is more important, to rectify the definition of previously known species and groups. His monograph, illustrated by eighteen beautifully executed plates in black and white, forms Bulletin No. 84 (173 4to pp.) of the U.S. National Museum. R. L.

OFFICIAL FISHERY PUBLICATIONS.[1]

IN its annual report for the year 1912, the fisheries branch of the Board of Agriculture and Fisheries made a marked change in the manner of reporting the results of their administration, and we are glad to note that this change is still more apparent in the report for last year. For the first time we are now presented with an account of the progress of the English sea fisheries, which is characterised by close insight into the conditions of the industry, and by a very attentive study of those tendencies that are making for the modification, in many ways, of the fisheries of England and Wales.

Part i. of the report is a document of great interest even to the ordinary reader interested in public affairs. It deals clearly and concisely with the industry in general, emphasising various matters of special importance arising during 1913. The remarkable herring fishery of the last two years; the great development, during this time, of the fishery for herring by means of the trawl net; the utilisation of by-products; the development of the internal combustion engine as a means of propulsion of fishing vessels; the application of wireless telegraphy in the deep-sea fisheries; the economics of the French sardine industry; the rapid development of scientific research by the Board: these and other matters, together with a good review of the year's fisheries and the administrative work of the Board, make up this interesting volume. Part ii. is a document for the specialist. It consists of statistical tables and synoptic charts, and those concerned with fisheries inquiries will welcome the increasing amount of detail exhibited in this representation of the year's fisheries. Still greater detail in relation to the less important fisheries is desirable, but it is apparent that, for this purpose, a much greater development of local administration by the Board may be necessary.

These reports are a contribution, though in a greatly modified and much more valuable form, of the former fisheries reports of the department. The third paper before us begins a new series of publications containing the results of scientific researches carried out by the officers of the Board. It is a statistical account of the English haddock fishery in the North Sea. The species is one which is most abundant in the northern parts of the North Sea, less abundant to the west of Great Britain, and practically absent, or capricious in its distribution and abundance, in the Irish Sea and the English Channel. Commercial statistics are utilised by Mr. Russell to give a picture of the distribution of the fish, and of its seasonal abundance, and the variations of abundance from year to year. These statistical summaries are most valuable; they indicate irresistibly those periodic fluctuations which are plainly to be correlated with periodic physical changes in the sea, or even with periodic cosmic changes. Measurements of length, of samples of fish taken at the great ports, are also summarised by Mr. Russell, and are so treated as to supplement the commercial statistics. In this way more than two and a half millions of fish have been dealt with. Biological observations have also been made, but a discussion of these is reserved for a future report.

Numerous determinations of average weight of the fishes landed are also summarised, with the object of throwing light on the variations in nutrition according to age and season. The author shows that the well-known length-weight formula now used in fishery investigations does not apply to his series. According to this formula, the weight of a fish at different ages is a function of the cube of the length. A mathematical investigation of Mr. Russell's average weights by Pearson's "method of moments" shows, however, that the weight of a fish at different ages is to be represented only by a series of the form,

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[1] Board of Agriculture and Fisheries. Annual Report on the Sea Fisheries for the Year 1913. Part i., Report; Part ii., Tables and Charts. [Cd. 7448–9] (1914.)

Fishery Investigations. Series ii., vol. i., part i., Report on Market Measurements in Relation to the English Haddock Fishery during the Years 1909–11. By E. S. Russell. (1914)

$$a + bl + cl^2 + dl^3 + \dots,$$

l being the length of the fishes. It is possible that these terms have each a physical meaning; the fish grows irregularly as its age advances, so that its weight is a function of length, surface, volume, and density, all of which dimensions vary in relation to each other in different phases of the individual life-history. J. J.

WATER SUPPLY.[1]

ONE of the difficulties besetting the agriculturist in the vast area known as the Great Plains and constituting the central region of the United States is the irregular rainfall. The land is fertile enough, but a recurring series of dry years militates greatly against its effective development. Attempts have been made to remedy the evil by means of artificial irrigation, but so far these efforts have been sporadic and local, and, consequently, they have not produced the completely beneficial results which might be obtained if all the ground water were systematically conserved and utilised.

The United States Government hydrological service, as the result of their investigations, are publishing from time to time a series of water supply papers specially devoted to a consideration of this problem as affecting various localities, and four reports before us (Nos. 345 A, B, C, and D), issued this year, deal with districts in Oklahoma, Kansas, and New Mexico. They are useful little pamphlets, affording much detailed information on the geological formation and available water resources of the respective areas. Not the least useful feature, perhaps, is a discussion on the depth and cost of wells, and on the power required for pumping. There is a much-needed caution to prospective irrigators to consider carefully the whole of the outlay likely to be involved in any system of artificial irrigation before embarking upon it, lest it should prove to be financially unremunerative and unsound.

Water Supply Paper, No. 340 A (Washington: Government Printing Office, 1914), of the United States Geological Survey, contains a list of the stream-gauging stations situated in the North Atlantic coast drainage basins, and a summary of the reports and publications relating to water resources within this area (1885–1913). It forms a convenient bibliographical index, and should prove most useful for reference purposes to anyone desirous of consulting the literature on the subject.

Three annual reports on the discharge of rivers in the United States are comprised in Water Supply Papers, Nos. 309, 322, and 324 (Washington: Government Printing Office). The first deals with the Colorado River Basin for the year 1911; the other two are for the year 1912, and cover the St. Lawrence River Basin and the basins of the South Atlantic coast and eastern Gulf of Mexico respectively. The numerous observations made have been carefully compiled and tabulated, and, in conjunction with those previously published, form a very useful scientific record of stream flow and discharge in the areas specified. Each pamphlet has an introductory note on the methods employed in gauging, and, in the 1912 reports, there are some interesting photographs and diagrams.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SECTION H.

ANTHROPOLOGY.

Opening Address by Sir Everard im Thurn, C.B., K.C.M.G., President of the Section.

A Study of Primitive Character.

Civilisation and "savagery"—for unfortunately it seems now too late to substitute any term of less misleading suggestion for that word "savagery"—are the labels which we civilised folk apply respectively to two forms of human culture apparently so unlike that it is hard to conceive that they had a common origin—our own culture and that other, the most primitive form of human culture, from which, at some unknown and distant period, our own diverged. But, assuming one common origin for the whole human race, we anthropologists can but assume that at an early stage in the history of that race some new idea was implanted in a part of these folk, that is, in the ancestors of civilised folk, which caused these thenceforth to advance continuously, doubtless by many again subsequently diverging and often intercrossing roads, some doubtless more rapidly than others, but all mainly towards that which is called civilisation, while those others, those whom we call "savages," were left behind at that first parting of the ways, to stumble blindly, advancing indeed after a fashion of their own, but comparatively slowly and in a quite different direction.

It is easy enough for civilised folk, when after age-long separation they again come across the "savages," to discern the existence of wide differences between the two, in physical and mental characteristics, and in arts and crafts; it is not so easy, it may even be that it is impossible, to detect the exact nature of these differences, especially in the matter of mental characters.

As a rule the occupant of this presidential chair is one who, whether he has seen much of "savages" at close quarters or not, has had much ampler opportunity than has fallen to my lot of comparative study of that great mass of anthropological observations which, gathered from almost every part of the world, has now been recorded at headquarters. I, on the other hand, happen to have spent the better part of my active life in two different parts of the world, remote from books and men of science, but in both of which folk of civilised and of savage culture have been more or less intermixed, but as yet very imperfectly combined, and in both of which I have been brought into rather unusually close and sympathetic contact with folk who, whatever veneer of civilisation may have been put upon them, are in the thoughts which lie at the back of their minds and in character still almost as when their ancestors were at the stage of savage culture.

While trying to adjust the mutual relations of wild folk and of folk of civilised stock, I have seen from close at hand the clash which is inevitable when the two meet—a clash which is naturally all the greater when the meeting is sudden. Moreover, having started with a strong taste for natural history, and especially for the natural history of man, and having had much guidance from many anthropological friends and from books, I have perhaps been especially fortunate in opportunity for studying the more natural human animal at close quarters and in his natural surroundings. I have tried, from as abstract and unprejudiced a point of view as possible, to understand the character, the mental and moral attitude, of the natural "savage" as he must have been when civilised folk first found him and, at first without much effort to understand him, tried abruptly to impose an extremely different and alien form of culture on this almost new kind of man.

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[1] Paper 345 *a*: Preliminary Report on Ground Water for Irrigation in in the vicinity of Wichita, Kansas. Paper 345 *b*: Ground Water for Irrigation in the vicinity of Enid, Oklahoma. Paper 345 *c*: Underground Water of Luna County, New Mexico. Paper 345 *d*: Ground Water for Irrigation in the valley of North Fork of Canadian River, near Oklahoma City, Oklahoma, Washington, 1914. Government Printing Office.

I venture to claim, though with diffidence, that I may have begun to discern more clearly, even though only a little more clearly than usual, what the primitive man, the natural "savage"—or, as he might more accurately be described, the wild man—was like; and it seemed possible that an attempt to bring together a picture—it can hardly be more than a sketch—of the mentality and character of some one group of people who had never passed out of the stage of "savagery" might be interesting and practically useful, especially if it proves possible to disentangle the more primitive ideas of such people from those which they subsequently absorbed by contact, at first with other wild, but less wild, folk, and later with civilised folk; and that a further study of the retention by these folk of some of their earlier habits of thought during later stages in their mental development might suggest a probable explanation of certain of their manners and customs for which it is otherwise hard to account.

The attainment of some such understanding is, or should be, one of the chief objectives of the practical anthropologist, not merely for academic purposes, but also for the practical guidance of those who in so many parts of our Empire are brought into daily contact with so-called "savages."

Perhaps hardly anywhere else in the world would it be possible to find better opportunity and more suitable conditions for such a study as I now propose than in the tropical islands of the South Seas. The ancestors of these islanders, while still in purely "savage" condition, must have drifted away from the rest of the human race, and entered into the utter seclusion of that largest of oceans, the Pacific, covering as it does more than a third of the surface of the globe, long before the first man of civilised race, Balboa, in 1513, from the Peak in Darien, set eyes on the edge of what he called "the Great South Sea," before Magellan, in 1520, forced his way into and across the same sea, which he called the Pacific, and certainly long before civilised men settled on any part of the shore of that ocean, *i.e.*, in 1788, at the foundation of Australia. For when first studied at close quarters by civilised folk from Europe, which was not until after the last-named event, these South Sea "savages" had been in seclusion during a period sufficiently long—and certainly no short period would have sufficed for such an effect—not only for them all to have assumed characters, cultural and even physical, sufficient to distinguish them from all other folk outside the Pacific, but also for them to have split up into many separate parties, probably sometimes of but few individuals, many of which had drifted to some isolated island or island-group, and had there in the course of time taken on further well-marked secondary differences.

It will probably now never be discovered when, how often, and from what different places the ancestors of these folk reached the Pacific. It is quite possible that they entered again and again, and were carried by winds and currents, some from west to east and some in the reverse direction, many perishing in that waste of waters, but some reaching land and finding shelter on some of that great cloud of small islands which lie scattered on both sides of the equator and nearly across that otherwise landless ocean.

Of the folk who in those old times thus drifted about and across the Pacific, the most important, for the part which they played in the story which I am endeavouring to tell, were the two hordes of "savages" now known respectively as Melanesians and Polynesians. Without entering deeply into the difficult subject of the earlier migrations of these two hordes, it will suffice here to note that, towards the end of the eighteenth century, when European folk at last began to frequent the South Sea Islands, and when consequently something definite began to be known in Europe about the islanders, certain Melanesians, who had probably long previously drifted down from north-westward, were found to be, and probably had long been, in occupation of the exceptionally remote and isolated Fiji Islands; also that, long after this Melanesian occupation of these islands, and only shortly before Europeans began to frequent them, several bodies of Polynesians, who had long been in occupation of the Friendly or Tongan islands, lying away to the east of Fiji, had already forced or were forcing their way into the Fijian islands.

The meeting in Fiji of these two folk, both still in a state of "savagery," but the Polynesians much further advanced in culture than the Melanesians, at a time before European influence had begun to strengthen in those islands, affords an exceptionally good opportunity for the study of successive stages in the development of primitive character, especially as the two sets of "savages" were not yet so closely intermingled as to be indistinguishable—at least in many parts of Fiji. It is unfortunate that the earlier European visitors to Fiji were not of the kind to observe and to leave proper records of their observations.

The earlier, Melanesian, occupants of Fiji had to some extent given way, but by no means readily and completely, to the Polynesian invaders. The former, not only in the mountain fastnesses difficult of access, but also in such of the islets as the local wind and weather conditions made difficult of access, retained their own distinct and simpler culture, their own thoughts, habits, and arts, long after the Polynesians had seized the more important places accessible to the sea, and had imposed much of their own more elaborate (but still "savage") culture on such of the Melanesian communities as they had there subjugated and absorbed.

The social organisation throughout Fiji remained communistic; but in the purely Melanesian communities the system was purely democratic (*i.e.*, without chiefs), while in the newer mixed Polynesian-Melanesian communities—as was natural when there had been intermingling of two unequally cultured races—there had been developed a sort of oligarchic system, in which the Melanesian commoners worked contentedly, or at least with characteristic resignation, for their new Polynesian chiefs.

Alike in all these communities custom enforced by club-law prevailed; but in the one case the administrative function rested with the community as a whole, while in the other it was usurped by the chiefs.

Though we are here to consider mainly the ideas, the mentality, of these people, it will be useful to say a few preliminary words as to their arts and crafts. The Melanesians during their long undisturbed occupation of the islands had undoubtedly made great progress, on lines peculiar to them, especially in boat building, in which they excelled all other South Sea islanders, in the making of clubs and other weapons, and in otherwise using the timber, which grew more abundantly, and of better quality, in their islands than elsewhere. Meanwhile the Polynesians, in their earlier homes and long before they reached Fiji, had developed, in very high degree, corresponding but different and much more elaborate arts (and ideas) of their own. But, as we know from Captain Cook, the Polynesians, despite their own higher culture, from their Tongan homes, greatly admired and appreciated the special craftsmanship of the Fijians, and it was indeed this admiration which attracted the former from Tonga to Fiji; and when the Polynesians had gained footing in the Fijis they—quite in accordance with human nature—were inclined, for a time at least, to foster the foreign Fijian arts—if not Fijian ideas—rather than replace these by their own arts; and before the struggle, both physical and cultural, between the two sets of "savages" had gone far it was interrupted, and more or less definitely arrested, by the arrival and gradual settlement of the still more powerful, because civilised, white folk from the Western world.

In turning to the earlier (Melanesian) occupants of Fiji, and especially to the less advanced of these, to find the traces of which we are in search of the more primitive habit of thought, it must not be forgotten that even at the stage at which we begin to know about them they had made considerable advance, in their ideas as well as in their arts and crafts. They still used their most primitive form of club, but also made others of much more elaborated form; so, though the ideas which lay at the basis of their habit of thought were of very primitive kind, they had acquired others of more complex character.

Before going further may I say—and I sincerely hope that suggestion will not be misunderstood—that in the difficult task of forming a clear conception of the fundamental stock of thought which must have guided the conduct of the more primitive folk we must constantly bear in mind the parallelism (I do not mean necessary identity of origin) between the thoughts of the earliest human folk and the corresponding instincts (as these are called) noticeable in the case of some of the higher animals? I am particularly anxious not to be misunderstood; the suggestion is not that even the most primitive human folk were mentally merely on a par even with the higher animals, but that many, perhaps most, of the ways of thought that guided the primitive man in his bearing towards the world outside himself may be more easily understood if it is once realised, and afterwards remembered, that the two mental habits, however different in origin and in degree of development, were remarkably analogous in kind.

A similar analogy, in respect not of thoughts but of arts, may well illustrate this correspondence between the elementary ideas of men and animals. The higher apes occasionally arm themselves by tearing a young tree up by the roots and using the "club" thus provided as a weapon of offence and defence against their enemies. Some of the primitive South Sea islanders did—nay, do—exactly the same, or at any rate did so until very lately. The club—the so-called *malumu*—which the Fijian, then and up to the much later time when he ceased to use a club at all, greatly preferred to use for all serious fighting purposes was provided in exactly the same way, *i.e.*, by dragging a young tree from the ground, and smoothing off the more rugged roots to form what the American might call the business end of the club. But though the Fijian, throughout the period during which he retained his own ways, used and even preferred this earliest form of club, he meanwhile employed his leisure (which was abundant), his fancy, and his ingenuity, in ornamenting this weapon, and also in gradually adapting it to more and more special purposes, some of the later of which were not even warlike but were ceremonial purposes, until in course of time each isolated island or group of islands evolved clubs special to it in form, purpose, and ornament, and the very numerous and puzzlingly varied series of elaborate and beautiful clubs and club-shaped implements resulted. It seems to be in power of improvement and elaboration that lies the difference between men-folk and animal-folk.

Something similar may be assumed to have brought about the evolution of the ideas of these islanders. Starting with a stock of thoughts similar in kind to the instincts of the more advanced animals, the human-folk—by virtue of some mysterious potentiality—gradually adapted these to meet the special circumstances of their own surroundings, and in so doing ornamenting these primitive thoughts further in accordance with fancy.

In the Fiji islands this process of cultural development was probably slow during the long period while the Melanesians, with perhaps the occasional stimulus afforded by the drifting in of a little human flotsam and jetsam from other still more primitive folk, were in sole occupation; yet it must have been during this period and by these folk that the distinctly Fijian form of culture was evolved. But the process must have been greatly accelerated, and at the same time more or less changed in direction, by the incoming of the distinct and higher Polynesian culture, at a time certainly before, but perhaps not very long before, the encroachment of Europeans.

In order to realise as vividly as possible what were the earlier, most elementary, thoughts on which the whole detail of his subsequent "savage" mentality was gradually imposed, it is essential for the time being to discard practically all the ideas which, since the road to civilisation parted from that on which savagery was left to linger, have built up the mentality of civilised folk; it is essential to try to see as the most primitive Fijian saw and to conceive what these islanders thought as to themselves and as to the world in which they found themselves.

It seems safe to assume that the primitive man, absolutely self-centred, had hardly begun to puzzle out any explanation even of his own nature, still less of the real nature of all the other things of which he must have been vaguely conscious in the world outside himself. To put it bluntly, he took things very much as they came, and had scarcely begun to ask questions.

He was—he could not but be, as the lower animals are—in some vague way conscious of himself, and from that one entirely self-centred position he could not but perceive from time to time that other beings, more or less like himself, were about him, and came more or less in contact with him.

The place in which he was conscious of being appeared to him limitless. He did not realise that he could move about only in the islet which was his home, or perhaps even only in a part of a somewhat larger, but according to our ideas still small, island; if other islets were in sight from that on which he lived, these also would be part of his world, especially if—though such incidents must have been rare—he had crossed to, or been visited by strangers from, those islands—islands which lay between his own home and that which he spoke of as *wai-langi-lala* (water-sky-emptiness) and we speak of as the horizon. To him the world was not limited by any line, even the furthest which his sight disclosed to him. Rarely, but still sometimes, strangers had come from beyond that line. Perhaps, too, he had some time heard that his ancestors had come from the somewhere which seemed beyond. Again, his ancestors of whom he had heard, and even some of the contemporaries whom he had seen, though no longer with him, except occasionally during his dreams, in bodily form, were somewhere, somewhere beyond that line of sight. Even he himself (in what were his dreams, as we say, but to him were part of his real life) habitually went beyond the line, and, so far as his experience had gone, returned each time to the island home.

Moreover, he did not doubt that this limitless region in which it vaguely seemed to him that he, and innumerable other beings, moved, extended not merely along what we speak of as the surface of the globe, but also, and equally, without any intervening obstacle, up into the infinite space above and beyond the sky. In short, to this primitive man the world, though the part of it to which he had access was so small, was limitless.

The thoughts of the dweller in this vague world, as to himself and as to the other beings of which from time to time he became conscious, must have been correspondingly indefinite.

He was, to a degree almost if not quite beyond our power of conception, a spiritualist rather than a materialist; and it is essential to get some idea of the extent and manner of his recognition of spiritual beings—and his corresponding non-recognition of things material.

In passing, I here disclaim, for myself at least, the use of the misleading word "belief" in speaking of the ideas of really primitive man—as, for instance, in the phrase the "belief in immortality." Possibly primitive men of somewhat more advanced thought, though not yet beyond the stage of "savagery," may have "believed" in spirits, in immortality, and so on; but it seems to me that at the earlier stage there can scarcely have been more than recognition (admittedly very strong recognition) of spiritual beings, and non-recognition of any beginning or ending of these spirits.

To return from this digression, Sir E. B. Tylor long since gave currency to the very useful word "animism," as meaning "the belief in spiritual beings," and this has been taken to mean that animism was the initial stage, or at any rate the earliest discoverable stage, of all religion. The primitive Fijian was certainly a thorough-going animist, if his extraordinarily strong but vague recognition of spiritual beings suffices to make him that; but I do not think that the ideas of that kind of the primitive "savage"—or, say, of the most primitive Fijian—before his ideas had been worked up into somewhat higher thought, during the long period while he was secluded in his remote islands, and before the advent of the Polynesians, had developed far enough to constitute anything which could be called "religion," though doubtless they were the sort of stuff which, had these folk been left to themselves, might, probably did, form the basis of the "religion" towards which they were tending.

Practically all human beings—savage and civilised alike—and, though in lower degree, even animal-folk, have in some degree recognised the existence of some sort of spiritual beings. The point, then, seems to be to discover what was the nature of the spiritual beings which the primitive Fijian recognised, but without understanding.

Anthropologists have recently defined, or at least described, several kinds of spiritual beings as recognised (even here I will not use the word "believed") by more or less primitive folk. There is, first, the soul, or the separable personality of the living man or other being; secondly, the ghost, or the same thing after death; thirdly, the spirit, which is said to be a soul-like being which has never been associated with a human or animal body; and, fourthly, there is, it appears, to be taken into consideration yet another kind of spiritual being (or something of that nature) which is the life of personality, not amounting to a separable or apparitional soul, which, it has been supposed, some primitive folk have attributed to what we call "inanimate things."

It seems, though I say this with all due deference, that this identification and naming of various kinds of spiritual beings, though it may hold good of animism at a higher stage, does not fit the case of the more primitive animist (say, that of the Melanesian in the very backward state in which, so far as we know, he first reached Fiji), for presumably he had not as yet recognised or differentiated between the various kinds just enumerated. He recognised something which may be called the "soul," which was the separable personality of the living man or other being. But he did not recognise—perhaps it would be better to say that he had not yet attained to recognition of—the ghost, or the same thing after death; for he had not even recognised any real break, involving change, at death. Nor, as I think, did he recognise a spirit, *i.e.* a soul-like being which had never been associated with a human or animal body; for he had no idea of any spiritual being which did not, or could not, on occasion associate itself with a human, animal, or other material body, nor seemingly had he reached the stage, labelled *animatism*, in which he would have attributed life and personality to things (which I take to mean things which are to us inanimate).

All that the most primitive man would recognise would be that he himself—the essential part of him—was a being (for convenience and for want of a better name it may be called "soul") temporarily separable at any time from the material body in which it happened to be, and untrammelled—except to some extent by the clog of the body—by any such conditions as time and space; he had found no reason to think that in these respects the many other beings of which from time to time he became aware (whether these were what we should class as men, other animals, or the things which we speak of as inanimate, such as stocks and stones, or bodiless natural phenomena, such as winds) differed from himself only in the comparatively unimportant matter of bodily form; moreover, it seemed to him that, as he himself could to some extent do all these, the other beings, and some perhaps even more easily, were able to pass from one body to another.

He felt that these "souls" were only temporarily and more or less loosely attached to the particular material forms in which they happened to manifest themselves at any moment, and that the material form in which the soul (and noticeably this held good even of his own soul) happened at any moment to be embodied was of little or no real importance to that soul, which could continue to exist just as well without as with that body.

Another point which it is important to note is the egoism of the savage man as distinguished from the altruism of the civilised man; for it was perhaps the beginning of the idea of altruism, of duty to one's neighbour, that gave the start to civilisation, and it was because the ancestors of the savage had never got hold of this fundamental principle altruism that they were left behind.

The uncivilised man, complete egoist as he was, thought and acted only for his own personal interests. It is true that he was to a certain extent kind (as we might call it) to the people of his own small community, and possibly still more kind to such of the community as seemed to him more immediately of his own kindred. But this kindness was little more than instinctive—little more than a way of attracting further service. It is also true that on the occasions, which must have been very rare till a late period in the Melanesian occupation of Fiji, when strangers—*i.e.* persons of whom he had not even dreamed—came, so surprisingly, into his purview, he was sometimes civil or even hospitable to those strangers (it should not be forgotten that to him these were souls embodied by separable accident in material forms); but this would have been only on occasions on which he knew, or suspected, that these visitors were stronger than himself, and able to injure or benefit him.

Another point of great significance in the character of this primitive man was that he had no conception of ownership of property. To him all that we should class as goods and chattels, his land, or even his own body, was his only so long as he could retain it. He might if he could and would take any such property from another entirely without impropriety; nor would he resist, or even wish to resist, the taking from himself of any such property by any one who could and would take it.

Again, the primitive man must have been far less sensitive to pain, and far less subject to fear, than the normal civilised man. I do not mean that the primitive Fijian was without the ordinary animal shrinking from physical pain, but that he cannot have been nearly as sensitive even to physical pain as is the more sophisticated man; nor had he the same mental pain, the same anticipation and fear of pain, that the civilised man has.

Having thus dealt with some of the more important points in the character of the primitive Fijian, I propose next to consider how far these suffice to account for some of the more "savage" conditions under which these islanders when first seen were living.

Cannibalism claims the first mention, in that, though the practice has been recorded from many other parts of the world, it is commonly supposed to have been carried further in Fiji than elsewhere.

Here, however, it is at once necessary to point out that the outbreak of cannibalism in Fiji in the first half of the last century was not due to any innate and depraved taste on the part of the Fijians, and that the practice to the degree and after the fashion of which the story-books tell was not natural to the Fijian, whether of Melanesian or Polynesian stock.

It is probable, even perhaps certain, that all the Fiji islanders occasionally ate human flesh before the coming of white men to the islands; but it was only after the arrival of the newcomers that this practice, formerly only occasional and hardly more than ceremonial, developed into the abominable orgies of the first half of the last century. The first Europeans to set foot—about 1800—and to remain in the islands for any time were the so-called "beachcombers." At first, at least, these renegades from civilisation, to secure their own precarious position and safety, contrived to put themselves under the patronage of some one or other of the great native chiefs, who would be Polynesians, and assisted and egged on these chiefs in their then main occupation of fighting other great rival chiefs, also Polynesians, and raiding the less advanced Melanesians of the surrounding districts. The guns and ammunition which the beachcombers, in some cases at least, brought with them or managed to procure, and the superior craft which they had imbibed from civilisation, greatly assisted them in this immoral purpose. Consequently a habit of cruelty, new to the Fijian, was implanted and developed, especially in the Polynesian chiefs. It became more and more a fashion for the greatest native warriors, thus egged on, to vie with each other in the number of their victims and in the reckless cruelty with which these were killed. Doubtless at first the victims were opponents killed in fight, sometimes great rival chiefs and sometimes mere *hoi polloi* who had been led out to fight, probably not very reluctantly, for their chiefs. Incidentally more and more people were killed; and the bodies of the slain were conveniently disposed of in the ovens. A taste for this food was thus developed in the chiefs—though this seems, for a time at least, to have been confined to the great chiefs, most of those of lower status, and all women, refusing to partake, at any rate until a later period. Before long, when the number of the killed ran short, the deficiency was made up by clubbing more and more even of their own people, until eventually the great native warrior took pride in the mere number of those he had killed and eaten.

It seems probable that even the coming of the missionaries, who first reached Fiji thirty or forty years after the earliest beachcombers, and at once began almost heroic efforts to stop cannibalism, thereby to some extent temporarily even aggravated the evil. For the chiefs, in their characteristic temper of gasconade, killed and ate more and more unrestrainedly, in mockery of the missionaries and to show what fine fellows they thought themselves to be.

To return from this digression into a somewhat distasteful subject, cannibalism as practised by the Fijians before the coming of white man was very different, and, from the Fijian point of view—if I may say so without fear of being misunderstood—not altogether indefensible. It must be remembered that there was, as it were, no killing in our sense of the word involved, merely a setting free from the non-essential body of the essential soul, which soul survived just as well without the body as with it.

Note that the soul must have been considered as in some way and for a time still associated with its late body if, as is commonly and perhaps rightly held, the slayer sometimes ate some part of the body of the slain in order to acquire some of the qualities of the slain.

Again, there can be little doubt that men were sometimes killed for sacrificial purposes, the material bodies of the victims being placed at some spot (perhaps the tomb) considered to be frequented by the disembodied spirit of some ancestor for whom it was desired to provide a spirit attendant. It may be noted that this sacrificial use of the body might be combined with an eating of the same body when once it had served its first purpose of attributing the spirit which had been in it to the service of the honoured ancestor.

It has been laid to the charge of the Fijians (as to that of many other folk of savage and even of civilised culture) that they habitually killed strangers, especially such as had been washed or drifted to the islands by the sea—who, in early times at least, must have been almost the only strangers to arrive. The charge, like that of cannibalism, has been exaggerated, and the facts—as far as there were any—on which this charge was founded have been misunderstood.

Here, again, the attitude of the Fijian in this respect was scarcely different from that of the lower animals in similar circumstances. The Fijian knew of no reason to be glad of the arrival of strangers, unless these could, in one way or another, be useful to him; and, as has already been explained, he knew of no reason why he should not make the best use possible of the stranger, of his body or his spirit, separately or together.

While, as must have been the case in earlier times, the newcomers were dark-skinned men like himself, the Fijian might without the slightest prick of conscience separate their bodies from their spirits, and dispose of the body or the spirit separately; or without effecting this separation, he might simply enslave the newcomers; or, again, if he suspected that the newcomers were too strong for him, he might yield himself to them as a slave.

And later, when Europeans began to arrive, sometimes as refugees from passing ships and sometimes as survivors from ships wrecked on the surrounding reefs, the bearing of the Fijian towards this new kind of stranger would have been on the same principles, only that in this case the newcomers, being of far less readily understood kind, would be regarded with more suspicion and also more respect. I believe that very seldom, if ever, was an inoffensive white man, wrecked sailor or other, killed, or treated with anything but kindliness and courtesy, even though the wrecked man's property might naturally be appropriated by the natives. It was only when white-skinned strangers became commoner, and frequently more offensive, and when familiarity had bred contempt, that they were killed, as nuisances, and, especially during the great outbreak of cannibalism, were eaten.

This point in the bearing of the islanders to white men might be further illustrated by a circumstance which, to my surprise, I have never found mentioned, *i.e.*, that during the whole period while the missionaries were, with a rashness only justified by the circumstances, testifying against the natives in Fiji not one of these was killed, until at a much later period, when European influence was all but predominant in Fiji, Baker was killed and eaten in very special circumstances.

If it were possible to ascertain in each case the facts as to the reception by "savages" of the first white men they saw, it would almost certainly be found that the reception was apparently kindly, though this kindness may really have been due to fear and not to charity. It was, however, quite probable that at any moment the savage might find that his dread of the white man was unfounded, and in that case he might kill him (*i.e.*, separate his soul from his body) without hesitation, and after doing this his fear—he probably never had any affection for him—of the disembodied spirit of the white man might be as great, or even greater, than before.

Incidentally it may here be noted, as a further curious point, that a Fijian who thus quite remorselessly set free the soul of a stranger from its body would probably not often and not for long in his dreams be revisited by his victim, if a native; and perhaps not even if the victim were a white man, unless very remarkable. In other words, the victim survives only just so long as he is remembered. Captain Cook, we know, survived for very long, perhaps does so still; few, if any, of such beachcombers as were later killed in Fiji survived for any length of time; and the innumerable natives who were drifted or washed to one or other of the islands must for the most part have passed from memory soon after they were killed.

It has been suggested that the killing of strangers may have been for the purpose of preventing the introduction of disease; and it is certain that, perhaps even before the coming of white men, the islanders recognised that the advent of strangers was curiously often and most disastrously followed by the introduction of new diseases, either real diseases or at least some queer, unexplained influence which has so often made life not worth living for savages where white strangers have been.

The Fijians were scarcely more notorious for cannibalism than for theft—and almost as undeservedly. There is scarcely an account of the visit of a European ship in early times to any of the islands which does not mention that the islanders who came aboard took whatever they fancied, either quite openly, or, if furtively, then without evincing anything like shame when discovered. This habit, which the explorers naturally called theft, was but the manifestation of a South Sea custom, due to the entire absence of any idea of personal property, which in Fiji is called keri-keri. To keri-keri was to take whatever you wanted and could take without the previous holder of the property preventing you. In old days no Fijian doubted his own absolute right to keri-keri, nor did he feel the very slightest shame in thus (as we should say) "depriving another of his property," or "stealing"; and even to this day the Fijian, provided that he is not really Europeanised, will keri-keri without shame. In short, the idea of ownership and individual property never occurred to the natural Fijian. He took what he wanted, and was strong enough to take. But, on the other hand, he yielded up, practically without reluctance, whatever another stronger or cleverer than himself wanted and was able to take from him.

Of the many other charges of "savagery" made against Fijians, I can, in the time at my disposal, deal with but one more, that as to their strange and gruesome habit of celebrating great occasions by killing their own folk. When a Fijian chief died, as we should say, or, as it seemed to the surviving natives, when his soul left the body which it had for a time used, his widows, and other of his kindred and dependants, unwilling to be left behind, were strangled, often, indeed, helped to strangle themselves, that their bodies might be put into the graves, while their souls went gladly with that of the chief whom they had been accustomed to follow.

Again, when a chief built a house, some of his dependants, whom the great man told off for the purpose, willingly stepped down into the holes which had been dug for the house-posts, and remained there while the earth was filled in on them, and continued thereafter as permanent supporters of the house.

Again, there is a tradition, which at least was not incredible to the natives, that a great chief one day went a-fishing, and caught many fish. Two brothers of humbler rank who happened to have come down to the same waterside, also to fish, were less successful. The chief, in a characteristic freak of generosity, presented his best fish to the elder of the two brothers, who, strictly according to Fijian custom, accepted the gift, but felt bound to make an immediate return, but he had nothing to give. Thereupon the younger brother, at his own suggestion, was clubbed by the elder, and his body presented to the chief in token that his soul would thereafter serve that chief.

It is even said that when yams and other vegetables were brought in as food for the chiefs by the dependants who had grown them for that purpose, the food-bearers, if there was a scarcity of fish or other suitable accompaniment for the vegetable diet, were themselves clubbed and their bodies eaten. This particular atrocity probably happened only after the habit of cannibalism had, as already explained, been unnaturally intensified. But the story is noteworthy in that the food-bearers are not represented as in any way dreading or shirking the use to which their bodies were put.

In all these and similar cases it is to be noted that the victims (as we are naturally inclined to call them) were more or less indifferent, if, indeed, they were not eagerly consenting parties, to the use (cruel as it seems to us) made of their material bodies. Thus the widows were eager to be strangled, and often even helped to do the deed, in order that they—all that was essential of them, *i.e.* their souls—should rejoin the deceased. Similarly those others who were killed on the occasion of the funeral were quite willing to give their bodies, which seemed of comparatively little importance, as "grass" to be added to the cut fern and other soft material on which the body of the deceased chief was couched in the grave; and quite willingly the men told off for that purpose stepped down into the holes in which the house-posts were grounded, that they, or rather their bodies, might thereafter hold up the house, while their souls enjoyed life much as before but without the encumbrance of the body. Others, again, contentedly grew *taro* for the chiefs to eat, and carried it in when ripe, thinking it of little importance that their mere bodies might be eaten with the *taro*.

In conclusion, having endeavoured to realise for myself, and to show you a glimpse of the enormous, scarcely conceivable difference in habit of thought, and consequently in character, which separates the savage from the civilised man, I will offer a suggestion which seems to me possibly the most important outcome of my personal experience, now closed, as an anthropological administrator in tropical places where Eastern and Western folk have met, and where the inevitable clash between the two has occurred.

In such places and circumstances the result has too often been that sooner or later the weaker folk—those whose ancestors have been age-long "savages"—have died out in the presence of those whose ancestors long ago turned from "savagery" to civilisation. This dying out of the weaker folk has happened even when the stronger people have done their best to avoid this extirpation.

The real ultimate cause of "the decrease of natives" when in contact with civilised folk lies, perhaps, in the difference in hereditary mentality—in the incapacity of the "savage" to take on civilisation quickly enough. However sedulously the missionary, the Government official, and others who take a real interest in so doing, may teach civilised precepts to the essential savage, the subject of this sedulous case—however advanced a savage culture he may have attained—will, at least for many generations, remain a savage, *i.e.* for just so long as he is under influence of the civilised teacher he may act on the utterly strange precepts taught him, but away from that influence he will act on his own hereditary instincts.

The manner in which the native dies out—even when well looked after—varies. He may be killed out by some disease, perhaps trifling, but new to him, with which he does not know how to cope, and with which—if he can avoid so doing—he simply will not cope in the ways which the civilised man would teach him; or he may be killed out by the well-meant but injudicious enforcement on him of some system of unaccustomed labour; or, again, he may die out because deprived of his former occupations (*e.g.* fighting and the gathering of just so much food as sufficed for him) and thus restricted to a merely vegetative existence; or in many other more or less similar forms his extermination may come about.

But all such effective causes are reducible to one, which is that he is not allowed to act on his own hereditary instincts, that he cannot at all times have, and often would not use, judicious and disinterested guidance from civilised folk, and that consequently he, the "savage," cannot and too often does not care to keep alive when in the presence of civilised folk.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. BENJAMIN MOORE, M.A., D.SC., F.R.S., PRESIDENT OF THE SECTION.

The Value of Research in the Development of National Health.

THE history of medical science presents to the curious student a remarkable development commencing in the latter half of the nineteenth century, and one worthy of special study, both on account of the light that it sheds on the present position and the illumination it affords for future progress.

If any text-book of medicine or treatise on any branch of medical science written before 1850 be taken up at random, its pages will reveal that it differs but little from one written a full century earlier. If such a volume be compared with one written thirty-five years later, it will be found that the whole outlook and aspect of medicine have changed within a generation.

Erroneous introspective dreams as to the nature of diseases, as "idiopathic" as the many strange maladies which their authors are so fond of describing have been replaced by fast-proven facts, and medicine has passed from an occult craft into an exact science based upon experimental inquiry and logical deduction from observation.

What caused this rapid spring of growth, after the long latent period of centuries, and are we now reaching the end of the new era in medicine, or do fresh discoveries still await the patient experimentalist with a trained imagination who knows both how to dream and how to test his dreams?

It is but a crude comparison that represents the earlier age as one of empiricism and imagination, and the later period as one of induction and experiment. Empiricism has always been of high value in science, it will ever remain so, and some of the richest discoveries in science have arisen empirically.

Imagination also is as essential to the highest scientific work to-day as it was a century ago, and throughout all time the work of the genius is characterised in all spheres of human endeavour by the breadth and flight of the imagination which it shows. The great man of science, whether he be a mathematician, a physicist, a chemist, or a physiologist, requires imagination to pierce forward into the unknown, just as truly as does the great poet or artist. Also, the inspired work of poet or painter must be concordant with a system of facts or conventions, and not outrage certain canons of his art, as certainly as the true and lasting work of the man of science must accurately accord with natural laws.

The man of science is as little able to prove the fundamental truth or existence of the groundwork upon which modern physical, chemical, and physiological theories are built, as the artist is to prove the ethics, or perfect truth, or perfect beauty, of those conventions upon which poetry, painting, or that great group of studies termed the "humanities" find their basis. But the artist or philosopher knows that, using these conventions as the best at present discovered, he can produce works of which the beauty and consistency appeal to all educated human minds capable of appreciation. Similarly, the conventions of natural science, properly understood, appeal to the imagination of the man of science, call forth new ideas to his mind, and suggest fresh experiments to test those ideas; or, a chance empirical observation of an experimental nature, which without theory and scientific imagination would remain isolated and sterile, placed in relationship to the rest of the scheme of science, awakens thought, and may lead to a fresh departure and a long train of important discoveries.

It was this correlation of the imagination with experimentation and the tracing out of relationship from point to point so as to develop the evolution of phenomena that characterised the science of medicine when new-born about seventy years ago, and differentiated it from the older nosological medicine in which imagination and experimentation, while both existing, seemed to possess independent existences and pay little regard the one to the other.

It seems well-nigh forgotten nowadays by the majority of people that science and religion originally began together from a common thirst for knowledge, and usually in the same type of mind endowed with a divine curiosity to know more of the origin and nature of things.

Every great religion worthy of the name contains some account of the natural history and creation of the world, in addition to its metaphysical aspects, and reflects the degree of knowledge of natural science possessed by the nation in which it arose at the time of its birth.

The fundamental error throughout the ages of human conceptions both in science and religion was that of a non-progressive world to which a stereotyped religion, or science, could be adapted for all time. Perfection was imaged where perfection, we are now happy to realise, was impossible, and, believing in this imaginary perfection and that all things new deviating from it were damnable, men were prepared to burn one another at the stake rather than allow error to creep into the world in either science or religion. Thus there have been martyrs for the scientific conscience just as for religious belief, and at this distance in time we can perhaps better understand both inquisitor and martyr and realise that both were fighting for great ideals.

Evolution has taught us that as knowledge broadens we must be prepared to have wider vision and abandon old theories and beliefs in the new-born light that makes the world better to-day than it was yesterday, and that also will show things up to our mental vision more clearly to-morrow than they stand out to-day. To the members of any great craft, or profession, or religious order, this scientific outlook which accepts as fundamental a progressive world, and insists that its votaries should adapt their lives to such a doctrine, is peculiarly difficult of assimilation. Routine fixes all men, and so when any new discovery appears to demand change from that order to which the mind has become accustomed, it is immediately looked upon with suspicion, and there being little plasticity of mind remaining, it is rejected as heretical or revolutionary after but scant critical examination. The cry of the craft in danger has been used efficaciously on many occasions since the days of the Ephesian silversmiths, nor is such a cry at once to be set down to pure selfishness. A craft is often worth preserving long after the forces which have called it into being have commenced to slumber, and conservatism of this type is at times an important factor in social progress. However, there are certain limits which must not be surpassed, room must be made by adaptation for the new knowledge, or it will establish a craft of its own iconoclastic to much worth preserving in the older system.

It is important to insist upon these limitations, because a too reactionary spirit abroad in medicine between 1860 and 1880 prevented the world from benefiting from those remarkable discoveries by Pasteur and their proposed applications by Lister, which laid the foundations of modern medicine and modern surgery. These pioneers of the new age in medical science had to wage for many years a stern and bitter fight against the strong forces of ignorance and prejudice. But for this illogical resistance by men who would not even test the new discoveries, and instead spent their time in sneering at the new geniuses who had leadership to give the world, France and Germany would have been saved many thousands of brave lives in the great war of 1870–71. Even thereafter, the slow struggle continued of the few who knew against the many who refused to be taught, and a perusal of any orthodox text-book of medicine published between 1875–80—that is, more than a decade after Pasteur's great discovery—will show that the etiology of scarcely a single infectious disease had become known, and that medical science was, for example, as ignorant of the nature of tuberculosis as we are to-day of the nature of carcinoma. Take, as an example, the following quotation from a well-known text-book of the theory and practice of medicine published in 1876: "It is now, however, generally admitted that tubercle is no mere deposit, but, on the contrary, a living growth as much as sarcoma and carcinoma are living growths." The tubercles were the only initial lesion observed, the infecting organism was entirely unknown, and the pathologists of this comparatively recent date argued at length as to whether tubercles were to be classed as "adenomata" or were something *sui generis*.

There is a gleam of sunlight for the future in this retrospect at the ignorance of the past, for, if men were as ignorant regarding tuberculosis thirty-eight years ago as to-day they are about cancer, then it may be argued that a generation hence as much may be known about cancer as is known now about tuberculosis.

It is particularly important at the present moment, when so much interest is being taken in national health, to point out the urgent necessity of allowing as little lagging behind as possible to ensue between the making of discoveries and the practical application of the results by organised national effort for the well-being of the whole community.

It must sadly be admitted that it is craftsmanship in imaginary danger fighting hard for the old methods unchanged which were in vogue fifty years ago that stands most prominently in the way of advance. As great a harvest as that which followed the application of the principle of antisepsis in surgery awaits the application of the self-same principle in national sanitation to-day, but the very profession which ought to be urging forward the new era apparently stands in dread of it, and seems to prefer to reap its harvest from disease rather than to seize the noble heritage won for it by the research of pioneers and so stand forth to the world as the ministry of health. Fortunately it cannot be, the bourne has been passed, and there is no going backward. The advances that have already been made have awakened statesmen and people alike to the needs of the situation, and all have resolved to be disease-ridden no longer. The laws of health must be made known to the people at large, and schemes laid before them for a national organisation for the elimination of disease. Disease is no longer an affair of the medical profession, it is a national concern of vital importance. The problem is not a class question, all humanity stands face to face with it now in the light of modern research as it never has faced it before. It has been realised that disease never can be conquered by private bargains for fees between individual patient and individual doctor. Research into diseases of unknown causation cannot be subsidised upon such individualistic lines, and in the case of diseases of known etiology and modes of propagation, the passage of disease from individual to individual cannot be controlled by such private methods as that of the afflicted individual subsidising the doctor for his own protection. Cost what it may, a healthy environment must be produced for the whole mass of the population, and the laws of physiology and hygiene must be taught not only to medical students, but to every child in every school in the country. People cannot live healthy lives in ignorance of the fundamental laws of health merely by paying casual visits to physicians, and no one class in the community can be healthy until all classes are healthy.

The problem of national health is one of peculiar interest to physiologists, and to the exponents of those experimental branches of medical science which have sprung from the loins of physiology, for it was with them that the new science of medicine of the last fifty years arose, and they ought to be the leaders of the world in this most important of all mundane problems.

It is well worth while to consider our opportunities and responsibilities and raise the question whether our present system and organisation are the most suitable for attaining one of the most sublime ambitions that ever appealed to any profession. By definition, our science studies the laws of health and the functions of the healthy body, therefore it is ours to lead in the quest for health. Is this object best achieved if we confine ourselves to research in our laboratories, and to the teaching of the principles of physiology to medical students, while we leave the community as a whole uninstructed as to the objects of our research and its value to every man, and trust the medical students whom we turn out to communicate, or not communicate as they choose, the results of their training and our research to the world at large?

There is little question that much of the ignorance abroad in the world, and much of the fatuous opposition to our experimental work and research, arise from this aloofness of ours. Here also lies the cause of much of the latent period in the application of acquired knowledge to great sociological problems, and the presence of untold sickness and death which could be easily prevented if only a scientific system of dealing with disease could be evolved.

The position occupied by men of science in medicine at the present day is largely that of schoolmasters to a medical guild, and even at that, one constructed upon lines which have grown antiquated by the progress of medical science. It ought now to become the function of the man of science to re-model the whole system so as to fight disease at its source. The whole situation at the moment calls out for such a movement. On the one hand, there exists a widespread interest on the part of an awakened community in health questions, evidenced by recent legislation dealing with the health of school children, with the health of the worker, with the sanitary condition of workshops, with the questions of maternity and infant mortality, and with the communication of infectious diseases. On the other, there is chaos in the medical organisation to meet all these new demands, and the ample means recently placed at the command of the nation and of municipal authorities are being largely wasted by overlapping and misdirection for lack of skilled leadership. Surely it is a time when those who have laid the scientific foundations for the new advances should take counsel together, assume some generalship, and show how the combat is to be waged, not as a guerilla warfare, but as an organised and coordinated campaign.

There are two essentials in the inception of this organised campaign against disease on a scientific basis. The first is to demonstrate clearly to the public mind that modern scientific medicine arose from the experimental or research method, that it was only when experimental observation of the laws of health and disease, in animals and man, commenced on an organised and broadcast basis that medicine and surgery leaped forward and the remarkable achievements of the past fifty years began. Also that it is only by the organisation and endowment of medical research that future discovery and advancement are possible. The second essential is to convince the public that a national system must be evolved placing medical science and medical practice in coordination, so that the discoveries of science may be adequately applied in an organised scheme for the prevention and treatment of disease. The method in which discoveries have been made in the past suggests an amplification and organisation along similar lines for the future, and the banishment of many diseases by public health work in the past suggests that it is more efficiently organised and widespread public health work in the future, extended from the physical environment to the infecting individual, that will be most fruitful in banishing other diseases.

If it be queried by anyone here, what has physiology to do with disease, it may be replied that the question comes at least fifty years too late. The methods evolved first by physiologists in experimentation upon animals have become the methods of all the exact sciences in medicine. Bacteriology is the physiology of the bacterium, and the study of protozoan diseases the physiology of certain groups of protozoa. Organotherapy had its origin in physiology, and many of its most brilliant discoveries were made by physiologists, and all by men of science who used physiological methods. Serum therapy, experimental pharmacology, and the great problems of immunity all arose from the labours of men with expert training in physiology who branched out into practical applications achieved by the extension of the experimental, or research, method. The modern methods of medical diagnosis and the brilliant technique of contemporary surgery, what has opened the door to these but the experimental method? From the days of the first successful abdominal operation to the present day, research in laboratory or in the operating theatre has pioneered the way, and the sooner this simple truth is known to all men the better for medical science. Every time any surgeon first tries a new operation there is in it an element of experiment and research of which the ethical limits are well known and definable, and any person who logically thinks the matter out must see that it is the research method which has placed the science and art of surgery where it stands to-day. Exactly the same thesis holds for medicine. How could any physician predict for the first time, before he had tried it experimentally on animal or man, the action of any new drug, the effect of any variation in dosage, the result of any dietary, of the employment of any course of physical or chemical treatment, or of anything in the whole of his armamentarium? Yet the public are rarely told any of these wholesale truths, but are rather left to speculate that each medical and surgical fact sprang forth as a kind of revelation in the inner consciousness of some past genius in medicine or surgery, who, in some occult way, knew of his own certain foreknowledge what would be the definite effect of some remedy or course of treatment before he tried it for the first time on a patient, or perhaps had the ethical conscience and genuine humanity to test it on a lower animal before he administered it to man.

It may, in short, be taken as an axiom of medical science that everything of value in medicine and surgery has arisen from the applications of experimental research. Nor can future advance be made by any other method than the research method. It is true that accident may teach occasionally, as it did, for example, in the dreadful burns unwittingly inflicted on themselves and patients by the early experimenters in X-ray therapy and diagnosis. But accident is only the most blundering type of experimentation, and results obtained by its chance agency do not really invalidate the universal law that man only learns by experience, or, in other words, by research. Research is, after all, only the acquisition of fresh experience by the trained expert, usually led on to his experiment by inductance from other known facts.

It has been said above that all that is valuable in medical science has been acquired by research; the converse may now be pointed out, that much that was valueless, dangerous, and even disgusting in medicine in earlier days was incorporated into the medical lore of the time, and often remained there for generations, stealing lives by thousands, because physicians had not yet adopted the research method, and so based their practice upon ignorant and unfounded convention. It is noticeable in literature that up to somewhere in the beginning of the nineteenth century physicians and surgeons were often as a class looked upon by scholars and educated people with a certain amount of contempt. There were notable and fine exceptions in all ages, but, taken as a whole, the profession of medicine was not held in that high esteem and admiration that it is amongst all classes to-day. Take, for example, Burns's picture of Dr. Hornbrook, or Sterne's account of Dr. Slop in "Tristram Shandy," and similar examples in plenty are to be found in the Continental literature. The reason for the change is to be found in the comparative growth of medical science as a result of the research method. The physicians of those days were very often ignorant quacks employing the most disgusting and dangerous remedies, or methods of treatment, based upon no experimental knowledge and handed down in false tradition from ignorant master to ignorant and often almost illiterate apprentice. It is only necessary to peruse the volumes written on *materia medica* of this period to shudder at the nature of the remedies apparently in common use; the details are unfit for modern publication.

Even in the first half of the nineteenth century patients were extensively bled almost to exhaustion in a vast variety of diseases in which we now know with certainty that life would be endangered by such treatment and chance of recovery diminished. Thus, in a text-book published in 1844 by the professor of medicine in the most famous university in medicine of our country, and a physician in ordinary to her Majesty Queen Victoria, it is said that in the treatment of pneumonia "the utmost confidence may be placed in general blood-letting, which should always be large, and must almost always be repeated sometimes four or six times, or even oftener. Blistering and purging, under the same cautions as in the bronchitis, are to be employed; and two other remedies have been much recommended—opium, especially combined with calomel, and the solution of tartar emetic." It seems scarcely credible to us nowadays that about this same period a low diet, blood-letting, emetics, and purgatives were employed as a treatment in phthisis; yet such is the case. It is in keeping with the above, and in strange contrast to modern treatment, to find it recommended that if the patient cannot winter abroad he is ordered "strict confinement within doors in an artificial climate, as near as possible to 60° Fahr., during at least six months of the year in Britain." From the text-books of medicine of this period, only seventy years back, instances of wrongful and even dangerous treatment in most of the important diseases might be produced. There is no basis of accurate scientific knowledge of physiology, biochemistry, or bacteriology underlying the visionary notions about disease. The real causes of the diseases being obscure, they are commonly set down to so-called diatheses or habits such as the "hæmorrhagic diathesis" or the "scrophulous habit." Also, the action of infective organisms and the intimate relationships in regard to infection of members of the same family being unknown or forgotten, such "habits" are erroneously set down as hereditary. When there is no other channel of escape, the word "idiopathic" is coined to cover the ignorance of the learned.

If now we pass onwards about thirty years in time, halving the distance between the above period and our own time, and consult an important text-book of medicine published in 1876 by a fellow of the Royal College of Physicians, a physician and lecturer at a famous London medical school, and a lecturer on pathology and physiology, we find that the progress attained by research in physiology and physiological chemistry, and a growing belief in the possibility of infection in many diseases by the micro-organisms, now demonstrated so clearly in certain cases by Pasteur and his followers, have commenced to do their beneficent work in medical practice. The heroic bleedings and leechings and the scarcely less violent druggings with strong drugs have disappeared. The patient is less harassed by his doctor, who is more content to assist the natural processes of recuperation as his knowledge of applied physiology and hygiene teach him, rather than to thwart them and to lessen resistance as his predecessor often did a generation ago, when he knew no physiology and less hygiene. Still, the comparison between the text-book of even forty years ago and one of the present day shows a wonderful advance, all flowing from the use of the research method in the intervening years, both in knowledge of the origins and in the treatments of the diseases.

Time and space forbid going into details, but the whole of serum-, vaccine-, and organo-therapy were unknown, with the single exception of vaccination for variola. Enteric fever has been separated from typhus, but its etiology is still obscure, and, to a large extent as a consequence, the mortality from it is 15 to 16 per cent., or quadruple present-day figures, and it is one of the commonest of diseases. The cause of diphtheria is unknown, although it is now recognised as a "contagious" disease, and as yet research in bacteriology has supplied no cure for it. The unity of the various forms of tuberculosis is unsuspected, the infecting organism is unknown, and, as a result, it is not even recognised as an infectious disease, and heredity figures most strongly in a dubious etiology, leading up to a vacillating treatment. Pneumonia is not recognised as due to a micro-organism, and is described as one of the "idiopathic" diseases. The cause of syphilis, and its relationship to *tabes dorsalis*, and general paralysis are unknown, and generally it may be said that the causes of disease are either entirely unknown or erroneously given in at least three-quarters of the very incomplete list of diseases that are classified and described.

This, after all the centuries, was the doleful position of medical science in the year 1876, when suddenly light began to shine upon it, brought not by the agency of any member of the medical profession, but by a physiological chemist, and he was led to his great discovery, not in an attempt to solve some problem of practical medicine, but by scientific observations devoted to an apparently purely philosophical critical research into the supposed origin of life in a particular way.

It was the experimental or research method in biochemistry supported by physiological experiments on animals which, in the hands of Louis Pasteur, laid the foundations of true knowledge, and transformed medicine from what has been described above into the glorious, living, evolving science that we possess to-day.

The men who fought side by side with Pasteur in his famous struggle against orthodoxy in medicine as represented by the leading physicians and surgeons of the period between 1860 and 1880 were mainly chemists, biologists, and physiologists, such as Claude Bernard, Paul Bert, J. B. Dumas, Biot, Belard, and Sainte-Claire Deville, in his own country, and Tyndall and Huxley in ours. A few physicians and surgeons of scientific training in France and England recognised the importance of his discoveries, such as Alphonse Guérin, Villemin, and Vulpian, in his own country, while Lister in ours was already at work, had experimented widely and wrote his memorable letter of congratulation to Pasteur in 1874, informing him of the work he had been doing in introducing antiseptic surgery in England during the preceding nine years. Against this intrepid little band of experimental men of science were massed all the batteries of orthodox medical nescience served by the distinguished physicians and surgeons of the time; but truth is mighty and must prevail. Davaine applying Pasteur's principles in a medical direction had found out the bacterial origin of anthrax, and although he was violently attacked by oratorical arguments in opposition to experimental proofs, and accused, as many physiologists are to-day, of having "destroyed very many animals and saved very few human beings," his facts held fast, and combined with the later experiments of Koch and of Pasteur, not merely established the etiology of anthrax as we know it to-day, but gave a support and forward growth to that new-born babe, bacteriology, which without such animal experiments could never have grown into the beneficent giant that it is to-day in all its glorious strength for the weal of humanity.

Pasteur himself meanwhile was hard at work in the small ill-equipped laboratory of physiological chemistry of the Ecole Normale at Paris, from which the fame of his discoveries began rapidly to spread and shed a new light forth on the medical world. Pasteur at this stage had already largely rehabilitated the national prosperity of his own country by his successful researches on silk-worm disease and on fermentation maladies and the diseases of wines. All this effect upon national industries, it is to be noted, followed on from an inquiry of apparently no practical importance on spontaneous generation. He now turned his genius towards disease, there also utilising the same discovery arising from a research that contained at first sight no possible applications to disease, and the remainder of his life was devoted to the extension of these studies. The subsequent history of this discovery is the science of bacteriology with all its ramifications and manifold applications in industry, in agriculture, in medicine, and in public health, investigated by the experimental method by thousands of willing workers all over the civilised world. Who but the ignorant Philistine, who knows not what he prates about, can deny the profound influence of animal experimentation, and the philosophic application of the principle of research upon the history of the world?

Let us now, from the vantage-point of the present, look back at the past and glean from the study of the manner in which this science took origin some knowledge to guide us, first, as to how research may be fostered and encouraged in the future, and, secondly, as to how the results of research may be applied for social advantage.

The first and perhaps the finest thought of all is that research must be pursued with the highest ideals of the imaginative mind apart from all desired applications or all wished-for material advantages. If we might personify nature, it would seem that she does not love that researcher who only seeks her cupboard, and never shows her finest treasures to him. She must be loved for her own beauty and not for her fortune, or she will ne'er be wooed and won. Not even the altruistic appeal of love for suffering mankind would seem to reach her ears; she seems to say: "Love me, be intimate with me, search me out in my secret ways, and in addition to the rapture that will fill your soul at some new beauty of mine that you have discovered and known first of all men, all these other material things will be added, and then I may take compassion on your purblind brothers and allow you to show them these secret charms of mine also, so that their eyes may perchance grow strong, and they, too, led hither by you, may worship at the shrine of my matchless beauty." By all the master discoveries in all the paths of science, nature is ever teaching us this great doctrine to which we have closed our ears so long. She tells us the creation of the world is not finished, the creation of the world is going on, and I am calling upon you to take a part in this creation. Never mind that you cannot see the whole, love that you see, work at it, and be thankful that I have given you a part to play with so much pleasure in it, and so doing you will rise to the highest ideal.

This is religion with thirst for knowledge as its central spring; does it differ much from those aspirations which have made men of all nations worship throughout all the ages? Anthropology teaches us that the religious system of a race of men gives a key to their advancement in civilisation. If this be so, growth in natural knowledge must elevate our highest conceptions, furnish purer ideals, and give us more of that real religion that is to be found running so strongly in the minds of great individuals, such as Isaac Newton, Michael Faraday, Louis Pasteur, Auguste Comte. A great man may be strongly opposed to the orthodox creeds of his day, he may even sneer at them, he may be burnt at the stake by their votaries, and yet be a man of strong religious feelings and emotions which have furnished the unseen motive power, perhaps unsuspected even by himself, that leads to a whole life of scientific heroism and enthusiasm.

The practical lesson for us to learn from all this is that we must consider research as sacred and leave it untrammelled by fetters of utilitarianism. The researcher in functional biology, for example, must be left free to pursue investigations as inspiration leads him on any living structure from a unicellular plant to a man, and must not be expected to devise a cure for tuberculosis or cancer. In his research he must think of something higher even than saving life or promoting health, or he is likely to prove a failure at the lower level also.

As an example of the wrong attitude of mind towards science, there may be taken the point of view of those utilitarians who complain of the amount of time and discussion at present being given to the problem of the origin of life. These wiseacres with limitations to their brains say "that is an insoluble problem, we shall never get to the bottom of it, let us simply assume, since it is here, that life did originate somehow, and, taking this as an axiom, proceed to some practical experimental problem; the origination of life does not lend itself to experimental inquiry."

Now it is, strange to say, just those problems that appear most insoluble upon which the inquiring type of mind loves to linger and spend its energies, and, although the problems never may be solved, the misty solitudes to which they lead are glorious and the fitful gleams of half-sunshine that come through are more kindling to the senses of such men, than the brightest sunshine on the barest of hills. It is here, and in such quests, that the biggest of human discoveries are made, and not all of them are in natural science alone.

The search after the mystery and origin of life had profound influence in raising man from a savage to a civilised human being, and is found as an integral part in all religions above a certain level of savagery. Much of the system of morals and ethics of civilised nations is unconsciously grouped round this problem, and we owe the existence of that social conscience which makes each of us our race's keeper to our interest in the nature of life, and our ties with other lives. Leave such a problem alone and attend to routine researches! Why, the human intellect cannot do it, such problems compel attention! What, it may be asked, was it that started all this routine research in biology, in favour of which we are asked to abandon the search after the origin of life? The routine research would not exist, but for a discovery made in investigating whether life originated in a certain alleged way.

If the whole science of bacteriology emerged from a proof that a certain alley did not lead to the origin of life, how much more glorious may that knowledge become that finally leads us to this goal, or even one step onward in our true path towards it. The search after the origin of life is an experimental inquiry, it leads straight to research, that is all the physicist or chemist demands of a theory; it should be enough for the biologist. We who search for this are not occultists, whatever may be said of those who oppose.

Let us then learn to have a catholic spirit about research, and try to convince the world that it commands devotion, not merely because of material advantages which it may bring, but because it is the most lovely and most holy thing that has been given to man. So may we clear the fair name of science of the false charge of materialism that is so often brought against it by those who do not know and judge science purely by mechanical inventions.

Next let us consider the applications of scientific discovery and see if we cherish aright the gifts of the fairy godmother, for her gifts are dangerous if wrongly used. Consider, if this be doubted, the enormous advantages given by mechanical and chemical contrivances in producing the material comforts necessary to civilised human existence, and then turn your eyes to the reeking slums of our great cities. It is clear that natural science cannot go on successfully alone, it must take sociology with it if our world is to be a better world to live in because of the gifts brought by scientific discovery.

Nor is the ideal and the outlook different in the least from that given above for pure research, when we come to consider its applications, the same high spirit must prevail in all our endeavours, or we shall defeat our own ends and miserably fail. Selfishness here, as everywhere, must recoil on the culprit, who only deadens his own soul. Health is needed not to grow wealthy or to prolong to greater length a "lingering death," as Plato puts it, but to fill life with happiness, and beckon the bold and adventurous forward to higher things. Here we must copy nature's own plan and take care of the race as a whole instead of spending our energies upon single individuals or favoured classes. Nor need anyone fear that any individual or any particular class in the community is going to suffer from the adoption of the true scientific attitude towards disease. The penalty taken by nature on the more comfortable classes who have hitherto enjoyed the greater share in government for allowing the existence of poverty, disease, and slumdom, is to utilise this neglected area as a culture-ground for diseases, which invade the classes above. Nature is still at work creating, still conducting evolution at the highest level, and disease is at present the tool with which she is working. So long as those poverty-stricken slums are allowed to remain, just so long is she grimly prepared to take her toll of death and suffering from those who ought to know how to lead on and do it not. The disease and the crime below are to the social community what pain is to the individual, and just as the special senses become more highly organised and sensitive as the nervous system becomes more highly developed, so as the civilisation of the community intensifies does the public conscience awaken to forms of mischief and crime in one generation that were unsuspected in a previous one. So social evils become intolerable and finally are removed. How then are we employing our knowledge as to the causation of disease to the public problem of its removal or abatement?

In regard to the physical environment much has been done during the past generation towards applying the laws of hygiene, as is shown in the sanitation of our great cities, and especially in regard to the question of water-supply. It is good, for example, that Glasgow goes to Loch Katrine for her water-supply, Manchester to the English lakes, and Liverpool to the Welsh hills. Each of these great cities carries for many miles the pure distillate of the hills to its million of inhabitants. It has cost much in pounds sterling, though not more than if each family had a pump in its backyard. On the other hand, think of the disease and suffering and death prevented, enteric fever almost gone where thousands would have died of it, and tens of thousands been debilitated, and these of the best of the citizens, for disease is no eliminator of the unfit. Think of all this, and then say, Did it not pay these great cities to bring the pure water from the lakes in the hills?

But why do these good cities content themselves to allow their little children at a most susceptible age to be supplied still with milk which contains the bacillus of tuberculosis in so large a percentage as 5 to 10 per cent.? And why does the law of the land prevent these corporations from searching out tubercular cows in all the areas supplying them with milk? If it is part of the business of a municipality to see that its citizens have a pure water-supply, why should it not also be allowed to see that they have a clean milk-supply?

Long ago the power to make the lame to walk was regarded as a divine gift. When is mankind going to awake to the fact that science has placed this gift in its hands? Much more than half of the lame and spinally-deformed children in our midst are in that condition because of infection of joints or spine with the bacillus of tuberculosis. By open-air hospitals and open-air schools we seek and succeed in curing a percentage of them, but how much better it would be if we took the fundamental problem of tubercular infection in hand and prevented them from becoming lame and deformed.

There is at present on foot in England a great scheme to enable the blind to read, and it deserves our support because it is our fault that these people are blind. The sad fate of the man born blind appeals to all kind hearts; but men are not born blind, they become blind within a week or two of birth because of an infectious disease contracted from the mother at birth. Science knows and has taught the world how this blindness can be quite prevented, and it is because of our faulty organisation for attending to maternities amongst the poor that these people are blind. By proper organisation practically all blindness arising at the time of birth can be prevented. Why is it not done? Thus our modern science can make the blind to see and the lame to walk, but it is so manacled by ancient ways and customs that it is left powerless, and so there are these maimed and darkened lives of innocent people, and they are left partially burdening the community which has only its own folly to blame for the whole stupid position.

Let us consider lastly a disease which collects the last toll from one-seventh of humanity, and debilitates and enfeebles the lives of many whom it does not entirely destroy. At all ages, in infancy, in the prime of life, and in life's decline, it snatches away the best of our fellow-men. How are we organising our campaign against tuberculosis? Bacteriology has taught us that it is an infectious disease and has isolated the organism. It is an undoubted fact, proven to the hilt by many inquiries and observations, that infection passes from individual to individual. How is this knowledge being applied, and how are we attempting to stem the tide of infection? In the United Kingdom alone about 70,000 persons die annually of the disease, and all over the civilised world the total death-roll of human kind annually from tuberculosis probably does not fall short of a million souls. This tide of infection is kept up, year in, year out, and every 70,000 dying annually in Britain must have infected 70,000 fresh victims before they themselves are carried away. Can it not be stopped, this foul tide of infection? What is being done to stop it? Sanatoria are being provided for the early cases, the bad and most infectious cases are largely being left alone to sow infection broadcast and then die. This is the chief means being used at present to stop the tide. The early non-infectious case is deemed the more important to look after, and the well-advanced, open, thoroughly infectious case is left to itself to infect others and then to die. This is the condition of our public health attitude in regard to tuberculosis. It is a travesty on the application of all biological laws, and in direct opposition to all laws of racial preservation. Industrial conditions have produced an artificial environment and enhanced the chances of infection by the organism of this disease; it should be our plan to copy nature's method and safeguard the interests of the community, and to do this we must proceed on the plan of separating the source of infection—that is to say, the infectious individual from the sound individual. This is done with success in the case of smallpox and cholera, and this plan has eradicated hydrophobia; why should it not be carried out in the case of tuberculosis? Under present conditions men, women, and children are going on unwittingly infecting one another by the thousand with tuberculosis in school, workshop, and home, and we who know it take no public action and raise no clamant outcry against it. It is of more value to the community to isolate one pauper far advanced in tuberculosis than to send ten early cases to sanatoria. This disease must be stopped at its source as well as dealt with on its course. No disease has ever been eradicated from a community by discovering cures for it, and none ever will; many diseases have disappeared because their sources have been cut off.

Let us be scientific, let us search out the truth; having found it, let us act upon it, and let us conceal nothing that is true.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—In consequence of the conversion of the new buildings at Edgbaston into a base hospital during the war, arrangements are being made whereby as much as possible of the work usually carried on there will be continued in Mason College and the Municipal Technical School. Unfortunately, some of the laboratory work will have to be curtailed, and much research work will be suspended.

The hostel for women students is at present used to accommodate the nursing staff of the hospital, but arrangements are being made to provide temporary quarters for the evicted students in a private house in Edgbaston.

The following notice of resolutions passed by the council on September 4 has been issued by the Vice-Chancellor:—(1) That the University will, so far as possible, continue its work for the benefit of those students who are prevented from undertaking active service in the Army or Navy, but that the University's advice to members of the staff, students, laboratory, and other assistants, and college servants, who are of suitable age and physically fit, is that they should enlist and serve their country. That students who propose to enlist should consult the Vice-Principal or the dean of the faculty of medicine, and (if minors) should obtain the written consent of their parents or guardians before sending in their applications. (2) That with a view of encouraging enlistment, the University undertakes to allow leave of absence to any of the above-mentioned persons during their naval or military service; that they be reinstated on their return with no loss of position or emoluments consequent on their enforced absence; that the council pay them (or such other person or persons as they may appoint) such sums as with the pay and allowances they receive from the Government will make up their full salary or wages; and that students shall be entitled to postpone any scholarships or other aids which they may hold, and, where possible, may be allowed to shorten the time of attendance at lectures necessary for a degree, without, however, the remission of any essential requirements in respect of examinations prescribed for their course.

MR. L. J. GOLDSWORTHY has been appointed professor of chemistry at the Victoria College of Science, Nagpur.

DR. D. WATERSTON, professor of anatomy in King's College, London, has been appointed to succeed Prof. J. Musgrove as Bute professor of anatomy, University of St. Andrews.

FOUR Gresham Lectures on heredity will be delivered on October 6, 7, 8, and 9, by Dr. F. M. Sandwith, at Gresham College, Basinghall Street, E.C. The lectures are free to the public, and will begin each evening at six o'clock.

THE Merchant Venturers of Bristol have decided to offer to engineering students of Belgian universities, or of the University of Lille, free places in the faculty of engineering of the University of Bristol, which is provided and maintained in their college. Of course, many of these students are at present serving with the respective armies, but it is hoped that any students who were unable to serve and who are, at present, in England will avail themselves of this offer.

THE new session of the Sir John Cass Technical Institute, Aldgate, E.C., which is especially devoted to technical training in experimental science and in the artistic crafts, will commence on Monday, September 21. The instruction in experimental science provides systematic courses in mathematics, physics, and chemistry for London University examinations, in addition to the courses on higher technological instruction, which form a special feature of the work of the Institute. In connection with the latter, several new departures are being made for the coming session. The curriculum in connection with the fermentation industries has been much developed and now includes courses of instruction on brewing and malting, bottling and cellar management, brewery plant, and on the micro-biology of the fermentation industries. A connected series of lectures dealing with the supply and control of power has also been arranged to meet the requirements of those engaged in works connected with chemical, electrical, and the fermentation industries. In the department of physics and mathematics a special course of lectures and demonstrations will be given on colloids, which will deal with the methods employed in their investigation and their relation to technical problems; also special courses of lectures on the influence of surface-tension on chemical phenomena, and on the construction and uses of physical instruments in their application to physical chemistry, on the methods of differential and integral calculus, and on the theory and applications of mathematical statistics, the latter of which will treat of the application and modern mathematical methods of dealing with statistical data in social, educational, economic, and physical problems. In the metallurgy department, in addition to the ordinary courses of instruction in general metallurgy, special courses of an advanced character are provided on gold, silver, and allied metals, on iron and steel, on metallography and pyrometry, on heat treatment of iron and steel, on mechanical testing of metals and alloys, on mining, mine surveying, and on mineralogy.

THE director of technical instruction in the Transvaal, at a conference held in Pretoria in November, 1913, on technical, industrial, and commercial education, has made a thoughtful contribution on technical education as it affects the training of the boy for industry ("The Trades School in the Transvaal." By W. J. Horne. *South African Journal of Science*, August, 1914). Naturally he deals with the peculiar conditions of industry in South Africa, having regard to the large employment of native labour, the special and sporadic character of the industries and the large use of automatic machinery. Whilst expressing the belief "that human nature can be ennobled by the organisation of industry in the service of education," the author deals rather with the training of the boy outside the industry, and attempts to show the possibilities of preparing him from quite an early age for some specific craft chosen as his future occupation. The type of school advocated is an apprenticeship school in which the boy is kept at work, including short breaks, for forty-seven hours a week, of which considerably more than half is workshop practice. The course extends over forty-eight weeks of the year, and is continued for three and a half years, payment being made to the pupil ranging from 8*d.* to 1*s.* 9*d.* per diem according as the pupil is graded. Little is done to ensure the general cultivation of all the child's faculties. He is regarded as the human factor in the industrial machine; only utilitarian ends are sought; not his own uses, but the uses of an industrial society are the aim. The employer is not regarded as having responsibility for the training of his employés. He must have them ready trained or simply as labourers. The author reviews the position of the trades school, in which theory and practice are taught—the industrial school exclusively practical—the manual training school which provides for the due training of all the child's faculties irrespective of future calling. The policy and methods of the trades school as here advocated will scarcely commend themselves to thoughtful British educationists.

THE new session of the Battersea Polytechnic opened on Tuesday, September 15, and particulars of all the courses and classes are given in the calendar of the Polytechnic. The following sections of the work are deserving of special notice: Full-day and evening courses in preparation for the intermediate and final degree examinations in science, engineering, and music are offered. In the day technical college full-time courses are arranged in mechanical, civil, electrical and motor engineering, architecture and building, chemical engineering and art, the courses covering a period of three or four years, at the end of which time students passing the necessary examinations are awarded the Polytechnic diploma. There are also full university and diploma courses in mathematics, physics, chemistry, botany, etc. Concurrently with the diploma courses, students can prepare for and take the degree examinations in science and engineering of the University of London. The training department of domestic science offers two-, three- or four-year courses in preparation for the teachers' diploma in domestic subjects, and the commerce department gives a course extending over two or three years in preparation for civil service and other examinations, and for secretarial and general business appointments. The physical training department for women offers a course extending over three years, and prepares students for posts as teachers of physical training, drill, gymnastics and games. The department of hygiene and physiology, which is housed in the fine block of buildings recently presented by the Drapers' Company, provides complete and comprehensive courses in the following sections: combined course of training for women sanitary inspectors and health visitors, courses for the higher and lower certificates in hygiene, and the course for the lower certificate in physiology. In view of the increasing attention which is being paid to the health and welfare of the community, this department has a wide and ever-growing sphere of usefulness before it.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 31.—M. P. Appell in the chair.—G. **Bigourdan**: Observation of the eclipse of the sun of August 21, 1914. The times of the commencement and end of the eclipse were observed under unfavourable conditions.—E. **Vallier**: Internal ballistics. Various formulæ from the recent work of N. Zaboudski. Experiments on the gas pressures and projectile velocities in 3-in. (76·2 mm.) cannon. Approximate formulæ are deduced for the velocities and pressures as functions of the weight of the explosive, weight of the projectile, length of the powder chamber, and thickness of the band of explosive.—Kr. **Birkeland** and M. **Skolem**: Calculation of the lines of equal intensity in the zodiacal light, on the supposition that it arises from the light diffused by a nebula of electrons or of radiant matter of solar origin. The formulæ deduced are illustrated graphically in seven diagrams.—H. **Bourget**: Partial eclipse of the sun of August 21 observed at the Observatory of Marseilles. The first and second contacts were observed under good conditions.—D. **Saint-Blancat** and L. **Montangerand**: Observation of the partial eclipse of the sun of August 21, 1914, at the Observatory of Toulouse. The times of first and second contacts are given.—I. **Tarazona** and V. **Marti**: Observation of the eclipse of the sun of August 20–21, 1914, made at the astronomical observatory of the University of Valentia (Spain).—J. J. **Landerer**: The total eclipse of the sun of August 20–21, 1914.—L. **Bouchet**: New determinations of Poisson's coefficient for vulcanised india-rubber. The pressures were produced by electrostatic means. The value found for Poisson's coefficient was appreciably equal to 0·5, signifying that india-rubber is incompressible.

BOOKS RECEIVED.

Smithsonian Miscellaneous Collections. Vol. lxiii., No. 7. New Subspecies of Mammals from Equatorial Africa. By E. Heller. Vol. lxiii., No. 1. Hodgkins Fund: Atmospheric Air in Relation to Tuberculosis. By Dr. G. Hinsdale. (Washington: Smithsonian Institution.)

Pendlebury's New Concrete Arithmetic. By H. Leather. First to Fifth Years. (London: G. Bell and Sons, Ltd.) 4*d.*, 4*d.*, 4*d.*, 6*d.*, and 6*d.*

British Association for the Advancement of Science. Australian Meeting, 1914. Handbook to Victoria. By A. M. Laughton and Dr. T. S. Hall. Pp. xvi+382. (Melbourne: A. J. Mullett.)

Brown's Marine Electrician, for Sea-going Engineers. By A. E. and A. H. Larkman. Pp. xv+244. (Glasgow: J. Brown and Son.) 5*s.* net.

Bacteria in Relation to Plant Diseases. By E. F. Smith. Vol. iii., Vascular Diseases (continued). Pp. viii+309+47 plates. (Washington: Carnegie Institution.)

Science and the Miller. By J. S. Remington. Pp. 166. (Liverpool: The Northern Publishing Co., Ltd.) 4*s.* 6*d.* net.

Forty-third Annual Report of the Local Government Board, 1913–14. Supplement to the Report of the Medical Officer. Third Report on Infant Mortality. Pp. vi+204. (London: H.M.S.O.; Wyman and Sons, Ltd.) 1*s.* 2½*d.*

A Theory of Civilisation. By S. O. G. Douglas. Pp. 246. (London: T. Fisher Unwin.) 5*s.* net.

A Course of Geometry, Theoretical and Practical. By A. H. Bell. Pp. vi+127. (London: Rivingtons.) 2*s.* 6*d.*

Manual of Fruit Insects. By M. V. Slingerland and C. R. Crosby. Pp. xvi+503. (London: Macmillan and Co., Ltd.)

County Folk-Lore. Vol. vii., Examples of Printed Folk-Lore concerning Fife, with some Notes on Clackmannan and Kinross-shires. Collected by J. E. Simpkins. Pp. xxxv+419. (London: Sidgwick and Jackson, Ltd.) 10*s.* 6*d.* net.

A Treatise on Dynamics. By Dr. W. H. Besant. Fifth edition, revised and enlarged by A. S. Ramsey. Pp. xv+443. (London: G. Bell and Sons, Ltd.) 12*s.*

Elementary Geometrical Optics. By A. S. Ramsey. Pp xi+173. (London: J. Bell and Sons, Ltd.) 6*s.*

The Deposits of the Useful Minerals and Rocks: Their Origin, Form, and Content. By Profs. F. Beyschlag, J. H. L. Vogt, and P. Krusch. Translated by S. J. Truscott. Vol. i. Pp. xxviii+514. (London: Macmillan and Co., Ltd.) 18*s.* net.

British Association for the Advancement of Science, 1914. Handbook for New South Wales. Pp. xiv+621. (Sydney: E. Lee and Co.)

New South Wales. Excursions arranged for Members of the British Association for the Advancement of Science, 1914 Meeting, Sydney, August 20–26. Pp. 78. (Sydney.)

Ceylon. Report of the Department of Agriculture for the period July 1, 1912, to December 31, 1913. Pp 36. (Colombo.)

Commonwealth of Australia. Further Investigations into the Etiology of Worm Nests in Cattle due to *Onchocerea gibsoni*. Pp. 56. (Melbourne: A. J. Mullett.)

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SPECIALISED GEOLOGY.

(1) *Structural Geology*. By C. K. Leith. Pp. viii + 169. (London: Constable and Co., Ltd.) Price 6*s*. 6*d*. net.

(2) *Geologischer Führer durch Nordwest-Sachsen*. By E. Krenkel. Pp. vii + 202 + 14 plates. (Berlin: Gebrüder Borntraeger, 1914.) Price 4 marks.

(3) *Australasian Fossils. A Students' Manual of Palaeontology*. By F. Chapman. With an introduction by Prof. E. W. Skeats. Pp. 341. (Melbourne and London: G. Robertson and Co. Propy., Ltd., 1914.)

(4) *Practical Instructions in the Search for, and the Determination of, the Useful Minerals, including the Rare Ores*. By A. McLeod. Pp. ix + 114. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 5*s*. 6*d*. net.

(1) MR. LEITH'S book does not cover so wide a field as Prof. James Geikie's "Structural and Field Geology," which was reviewed in this journal in 1912 (vol. xc., p. 159), nor is it so attractive at first reading as Prof. Wilckens's "Grundzüge der tektonischen Geologie" (NATURE, vol. xcii., p. 564). But it represents the application of close thinking to the problems of earth-fracture and the displacement of rock-masses in regard to one another, and it forms a specialised manual for the student of all kinds of rock-flow. The large amount of sliding and differential movement that takes place between layers of the same contorted series may be well realised in the field; but it is not apparent in our ordinary diagrams. Mr. Leith, on p. 114 and elsewhere, very usefully directs attention to it, and connects the "drag-folds" seen on a small scale with the overfolded structure of the Alps. Willis's terms, "competent" and "incompetent," which are too familiar in their ordinary usage, are adopted (p. 111) for layers of rock that respectively resist and yield to compound crumpling. A fold may exhibit "competence" up to a certain point, and may become "incompetent" on continuance of pressure, yielding in this case as a series of folds in which the successive beds are similarly curved. The book is full of matter that leads to accurate realisation, and includes useful reviews of such widely separated terminals of the subject as the origin of joints and the theory of isostasy.

(2) In his description of North-west Saxony, Dr. E. Krenkel has the advantage of dealing with a district that includes a palæozoic range folded in Middle Carboniferous times, a conspicuous development of Permian strata with associated volcanic rocks, Oligocene and Miocene brown coals, and boulder-clay in which Scandinavian granite (rappakiwi) has been found. The combination is a happy one for those who study geology at Leipzig, though there is a large gap in the stratigraphical succession. The glacial and fluvioglacial deposits contain the mammoth, *Rhinoceros mercki*, and the reindeer. Ice-scratched surfaces are noted at several points, and the dry epoch at the close of the last ice-age has left its traces in the form of grooves etched by wind-borne sand on the porphyry cliffs of the Klein Berg (p. 91). The contact-metamorphism due to granite of Carboniferous age is studied in the last of the excursions, and the question is left open as to whether the associated gneisses are a marginal type of the granite, or an older mass into which the latter has intruded (p. 180).

(3) The early association of Mr. F. Chapman, now of the National Museum, Melbourne, with the detailed researches of Prof. Rupert Jones gave promise of the accurate contributions that he has made to Australian palæontology. It is an admirable sign of the times that Great Britain is no longer the field to which problems of the southern hemisphere must be referred. The publication of an introduction to the study of fossils in which Australian examples are primarily employed cannot fail to stimulate observation, and such absorbing details as the "Collyweston Slate" and the "Oldhaven Beds" may in time drop out of view in examination papers set for our antipodes. At the same time, the author will be the first to recognise that notable gaps in the record must be filled in by reference to other lands. The Triassic cephalopods and almost all fossil mammalia serve as notable examples, and a "students' manual of palæontology" may be expected to lay a broader foundation than is here given. Mr. Chapman's book, however, is justified by its principal title, and it will be of immense help to workers in Europe who require a ready reference to species recognised on the other side of the equator. The bibliographies following each chapter still further deserve our gratitude.

(4) Mr. McLeod's book is bound for the pocket, and contains useful hints for the prospector, who is shown how to perform a number of tests with ingenious and simple apparatus. It is, however, taken for granted that he will not be interested in the reactions involved. The chemical composition of minerals is loosely stated, and a mixed list of minerals and chemical oxides on p. 81 is styled a list of "ores." The mouth-blowpipe is not relied on; yet it would reduce cassiterite in

a tenth of the time occupied by the method given on p. 37, while a candle is often easier to deal with in experiments requiring heat than the "brisk wood fire" advocated on p. 23. We should like a prospector to take up this practical little book after an elementary course in mineralogy; but this seems too much to ask of those whose energy and observation may affect the fortunes of huge companies. G. A. J. C.

INSECTS AND DISEASE.

A Text-book of Medical Entomology. By Dr. W. S. Patton and Dr. F. W. Cragg. Pp. xxxiv + 768 + lxxxix plates. (London and Madras: The Christian Literature Society for India, 1913.) Price 15.12 rupees, or 1*l.* 1*s.*

THE vast literature which has sprung up in connection with medical entomology gives some indication of the importance of this comparatively new subject, and the work under review is the first attempt at a text-book. The subject chiefly concerns those medical and veterinary officers practising in the tropics, frequently out of the reach of current literature, and this book is designed to give to these men a concise introduction to entomology in so far as it is connected with medicine.

The book is divided into twelve chapters, and of these the first four, occupying rather more than half the volume, deal with flies. The bloodsucking and other noxious types of these insects are dealt with very fully, and chapter ii., which is entitled "Anatomy and Physiology of the Blood-sucking Diptera," is perhaps the best in the book. The different types of "biting" flies are discussed as to general structure and internal anatomy, and the question of the origin of the mouth-parts of the "biting" from the "nonbiting" Muscidæ is made an excuse for bringing in an excellent description of the mouth-parts of the house-fly.

Chapters v. to x. deal with fleas, bugs, lice, ticks, mites, and the pentastomids or "tongue worms," the latter two groups, although not insects, being usually regarded as coming within the meaning of the term "entomology."

The book is well illustrated, there being eighty-nine plates, the majority of the figures being original sketches by the wife of one of the authors, and many of these indicate a large amount of careful dissection.

There are a few mistakes, such as that in bugs the "mandibles are so opposed as to form a channel with a circular lumen, while the maxillæ are armed with cutting teeth" (p. 6), and there are occasionally definite statements made upon debatable points, as with regard to the number of segments composing the insect head (pp. 9 and 13); but the chief complaint we have to make is against the way the book has been edited. There are, for instance, some sentences which are either difficult to understand or altogether unintelligible. Thus, on p. 7 we read, "In the Diptera . . . the sucking tube is formed by the outgrowth from the pharynx of two spatulate slips, one dorsal and the other ventral," and it is not until p. 21 that we find the real meaning of this extraordinary statement, where it is said, "In the Diptera [the adaptation of the mouth for sucking] is accomplished by the development to a very high degree of just those parts of the mouth apparatus which are rudimentary in the cockroach, namely, the epipharynx and the hypopharynx. These are outgrowths from the dorsal and ventral walls respectively of the stomodæum. . . ."

On p. 15 is the cryptic statement: "When the head [of a fly] is viewed from behind the whole of the posterior wall is seen to be chitinous, while at the lower border there is a rounded foramen between the anterior and posterior surfaces through which the proboscis is protruded."

Again, in various places we find references to earlier passages which it is almost impossible to trace. Thus, on p. 130, "The relations of the hæmatocœle of the proboscis of the fly have been described at some length in connection with the mechanism of the mouth-parts." But there is no section entitled "Mechanism of the mouth-parts"! There is a heading "Mechanism of the proboscis," but the required statement is not there, and it is only from three words in one sentence that one gets a hint, and we ultimately find what we want under "Movements of the Labella" in connection with a description of the proboscis of Musca (p. 46).

One other complaint we make with regard to the difficulty of using the book. In a number of cases there is much lettering on the plates, and there is the greatest difficulty in finding the explanatory pages. There is a page of reference letters to cover plates i. to vii. immediately following plate i. and just before plate viii. is a page to cover plates viii. to xiii, but there is nothing on any of the plates to indicate where the explanatory pages are to be found. Unfortunately also the page of reference letters for plates i. to vii. is almost wholly wrong.

There are thus many faults in the book, and they are the more to be regretted since much of the material is really first-class. It can only be hoped that the work will run to a second edition in which these defects can be remedied.

FRANK BALFOUR BROWNE.

THE INIMITABLE OBSERVER.

Fabre, Poet of Science. By Dr. C. V. Legros. With a Preface by J. H. Fabre. Translated by Bernard Miall. Pp. 352. (London and Leipzig: T. Fisher Unwin, n.d.) Price 10*s.* net.

The Life of the Fly. With which are interspersed some Chapters of Autobiography. By J. Henri Fabre. Translated by A. T. de Mattos. Pp. xi + 508. (London: Hodder and Stoughton, n.d.) Price 6*s.* net.

MANY who have enjoyed Fabre's entomological studies will be glad to have an opportunity of knowing the author more intimately, and we have to thank Dr. Legros for a fascinating biography and appreciation, which has been admirably translated by Mr. Bernard Miall. Jean-Henri Fabre was born at Saint-Léons, in the canton of Vezins, in 1823, some seven years earlier than Mistral. From his childhood he was a lover of nature and poetry, and though he was brought up amid the rudest privations, they did not freeze "the genial current of his soul." As a school-teacher at Carpentras, with 28*l.* a year, often in arrears, he continued his own education, and all was grist that came to his mill. He had an enthusiasm for knowledge—about plants, rocks, coins, mathematics, chemistry, physics, and what not. When he attained his majority he had the courage to marry. A period in Corsica, as a teacher of physics, was marked by a revived enthusiasm for mathematics, and by meeting Moquin-Tandon, who initiated him in the discipline of dissection. The next period was at the Lycée of Avignon; and it was there, in 1854, that a volume by Léon Dufour, then "the patriarch of entomologists," decided his vocation. In spite of having to work excessively hard to keep the family table spread, and in spite of every possible discouragement, Fabre produced in a few years a series of studies which made his reputation among entomologists. As early as 1859 Darwin spoke of him as "that inimitable observer."

There can be no doubt that Fabre's life was terribly severe. An observer of the first rank had to eke out a miserable salary with "abominable private lessons" which spoiled his temper and wasted his energies. His discovery of a profitable way of extracting the pigment of madder was snatched from his hands, and his dream of freedom to follow his vocation faded away. His free popular lectures at the Abbey of Saint-Martial at Avignon are said to have been famous for a generation, but it is more certain that they aroused jealousy and ill-feeling. He was turned out of his house, and might have come entirely to grief had it not been for the kindness of John Stuart Mill, who was then residing at Avignon. After twenty ill-rewarded years of service, Fabre shook off his yoke and retired in 1871 to Orange. He kept things going in a precarious hand-to-mouth fashion by writing introductions to the various sciences, which had a great vogue in their day, and had certainly the great merit of teaching much in a heuristic fashion with the simplest possible apparatus. But Fabre's fine work was ill-paid; the keepership of the Requen Museum at Avignon was taken from him; he lost a son of great promise; he had a very serious illness; his cup of bitterness was full. When his landlord at Orange lopped the double row of plane-trees which formed an avenue before his house, he could endure towns no longer, and retired to the peaceful obscurity of Sérignan—"a quiet corner of the earth which had henceforth all his heart and soul in keeping."

In his hermit's retreat, living an ascetic life, Fabre gave himself up to observation and reflection, and produced the well-known studies—at once poetic and scientific—that fill the ten volumes of the "Souvenirs Entomologiques." After forty years of desperate struggle he had won for himself freedom, and he used it nobly. "For thirty years he never emerged from his horizon of mountains and his garden of shingle; he lived wholly absorbed in domestic affections and the tasks of a naturalist." He remained extremely, sometimes painfully, poor, and was often worried; but he made a big success of his life, and if he has had many hardships and sorrows he has found in the *vis medicatrix Naturae* much more than healing. His wide scientific interests and culture made him an all-round naturalist; his genius as an observer, not equalled since Réaumur, brought him into extraordinarily intimate acquaintance with the objects of his study; his indefinable sympathy helped him in tracking the mysterious paths of instinctive behaviour. It need not be supposed that he has been without exception accurate, for he has sometimes read too much of the man into the beast; but what eyes the man has had! It cannot be maintained that his judgment has always been sound—witness his dogged anti-evolutionism—but there have been few naturalists who have got so near the intuition of life. We would pay homage to the veteran; he has peaceful satisfaction in the twilight of his days for he knows that he has the gratitude of all who love nature.

A good sample of Fabre's essays will be found in the selections from the "Souvenirs Entomologiques" which have been excellently translated by A. Teixeira de Mattos and published under a somewhat inaccurate title, "The Life of the Fly."

The Life of Flies would have been nearer the mark, for most of the essays deal with Diptera. There are others, *e.g.* on pond-life, caddis-worms, insects and mushrooms, which have not much to do with flies, and the interspersing of biographical chapters—charming as they are—removes the book even further from being a unity. The essays, like everything Fabre wrote, are vividly interesting; they discover to us the wonder of life; they set us thinking; they make us wish to go out and observe. The now well-known style suffers necessarily in translation, but it is extraordinarily picturesque and arresting. We confess to getting wearied when the conversationalism and anthropomorphism is too prolonged; but it is marvellously fine. "I pry into life," Fabre said, and these essays give us some idea of his reward. As the translator has done his work well, and will doubtless do more, may we suggest that the repeated wrong use of the term "species" in the notes is irritating, that starfishes cannot be included in the modern use of the word zoophytes, that the natterjack "sometimes as large as a plate," excites remark; and so does "underneath, in a pool of sanies, is a surging mass of swarming sterns and pointed heads. . . ."

AN ITALIAN TEXT-BOOK OF METALLOGRAPHY.

Le Leghe Metalliche ed i Principii Scientifici della Metallografia Moderna. By Prof. Domenico Mazzotto. Pp. xi + 421. (Modena: G. T. Vincenzi e Nipoti, 1913.) Price 6 lire.

PROF. MAZZOTTO'S work is the first complete treatise on metallography in the Italian language. It is very similar in scope to other text-books which deal with the chemical rather than the engineering aspect of the subject, and the treatment is throughout mainly theoretical. As might be expected from the nature of the author's original publications, the quantitative interpretation of the equilibrium diagram receives much attention, and the student will find in these chapters a useful review of the possible types of equilibrium amongst alloys. The ternary and quaternary systems, which have been studied chiefly by Italian metallographers, are also described with the aid of diagrams.

This theoretical section is followed by the discussion of a limited number of actual systems, and this part of the work is somewhat less satisfactory. A more critical treatment of the experimental material would have been of great advantage, as several systems are represented by diagrams taken from early investigations, which later researches have shown to be incorrect. The copper-manganese series is a conspicuous example, the maximum in the second diagram being due to the presence of carbon in the materials employed by Wologdine.

Practical methods are only briefly described, but the usual methods of taking cooling curves are illustrated and explained. Several forms of pyrometer are included, however, which are useless for metallographic work, being designed only for the approximate measurement of furnace temperatures in works practice. Microscopical methods occupy only a few pages, but some photo-micrographs are reproduced from well-known sources.

The general sections on physical and mechanical properties, and on the modes of formation of alloys, although brief, are well written, and should serve as an interesting introduction to the subject for students previously unacquainted with it. The impression of metallography which such students will obtain is somewhat one-sided, but the science is new in Italy, and the admirable work which has been done already by such investigators as Bruni, Giolitti, Parravano, and Mazzotto is a guarantee that it will become firmly established there. By the time the author is called on to revise the present book, his attention will probably have been directed to those aspects of the subject which are now unrepresented, and it will be possible, by reducing the disproportion between the several parts, to render an excellent introductory text-book still more valuable.

C. H. D.

OUR BOOKSHELF.

A Practical Treatise on Sub-aqueous Foundations, Including the Coffer-Dam Process for Piers, and Dredges and Dredging, with numerous Practical Examples from Actual Work. By C. E. Fowler. Third edition, revised and enlarged. Pp. xliii + 814. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 31*s.* 6*d.* net.

THIS book first appeared in 1898 under the title "The Coffer-Dam Process for Piers." The title was altered in 1904 to "Ordinary Foundations, including the Coffer-Dam Process for Piers." The work now presented under the title given above contains a large amount of new matter, consisting of practical examples of work, much of which has been constructed by the author, or with which he has come in intimate contact in a consulting capacity. Among the new subjects treated may be noted concrete piles, the jetting of piers, metal sheet-piling, the open-dredging process, caisson work and caisson disease, diving, the bearing power of soils.

An attempt has been made to render the book so complete that the engineer may find it unnecessary to consult other volumes in order to obtain information regarding the subjects covered. We are afraid that this claim is too wide. The engineer will find a great deal of information of a practical character in the volume, together with methods of calculation (often short cuts) which will enable him to carry through his designs, but to understand completely what he is doing he will certainly either have to possess other knowledge or consult other books. For example, in the section dealing with the calculations of piers, footings and retaining walls, earthwork problems are treated sometimes by the wedge theory, elsewhere by Rankine's theory, and again with friction allowance on the wall. Attention is not directed to the differences of these methods. The treatment of the pressures on the base of the wall is not at all clear, and will leave the engineer who uses the method given in a state of uncertainty as to what he has really done.

Principles of Metallurgy. By A. H. Hiorns. Second edition. Pp. xiv + 389. (London: Macmillan and Co., Ltd., 1914.) Price 6*s.*

It is almost twenty years since the first edition of this book appeared. During that time metallurgy has advanced very rapidly, and any new book or new edition which is published should have many novel features to indicate.

The present volume reviews briefly the principal metallurgical phenomena and extraction processes and forms one of a series by the author. It is a work which is intended for use in a technical school and for the instruction of apprentices and other workers engaged in the metal industries and whose employment demands some elementary knowledge of metals, their properties, and methods of production.

As a consequence of attempting to cover the whole field of metallurgy in some 370 pages, the author has treated several sections rather scantily, while others are out of proportion to their importance. Thus, in the paragraph on the Bessemerisation of copper, no discussion is given of the true function of the furnace lining, and although a "more or less basic" lining is mentioned, no stress is laid upon the recent adoption of basic-lined converters. It is noticeable, too, that the author occupies twelve pages in descriptions of various, almost obsolete, chlorination processes for the treatment of gold ores, whereas he dismisses the more important cyanide process in three pages.

The work is suitable to place in the hands of a young student on his earliest venture into the domains of metallurgy, but he would be well advised to pass, at an early stage, to the larger treatises on the subject. W. A. C. Newman.

Gearing: a Practical Treatise. By A. E. Ingham. Pp. xi + 181. (London: Methuen and Co., Ltd., 1914.) Price 5*s.* net.

The object of this volume is to present in a simple manner the general scientific principles which underlie the subject, and to give particulars of the most approved methods of solving problems connected with various forms of gears. Spur, bevel, worm, spiral and helical gears are included, and methods of cutting these gears are explained and illustrated by photographs. The calculations given are of the simplest possible character and should present no difficulty to anyone who knows ordinary arithmetic. Extensive tables are given which will simplify the process of finding the pitch, diameter, and outside diameter of wheels having a given circular pitch. A considerable amount of space is taken up with blacked drawings showing the comparative sizes of teeth having progressive diametral and circular pitches. The latter might have been omitted, and space found for a discussion of the new problems introduced by the applications of helical wheels in marine turbine speed-reduction gears. The desire of the author to keep the matter treated within the limits of simplicity prescribed by the knowledge of the readers he has in view no doubt accounts for the many omissions in an otherwise useful volume.

Historical Sketches of Old Charing: The Hospital and Chapel of Saint Mary Roncevall; Eleanor of Castile, Queen of England, and the Monuments erected in Her Memory. By Dr. J. Galloway. Pp. 82. (London: John Bale, Sons, and Danielsson, Ltd., 1914.) Price 10*s.* 6*d.* net.

These studies in the history of Old London, by the senior physician and vice-president of Charing Cross Hospital, originally published in the hospital *Gazette,* and reprinted for the benefit of that institution, form a useful contribution to local history. The first part contains an account of the hospital and chapel of St. Mary Roncevall at Charing Cross, a branch house of the great convent at Ronesvalles in the western Pyrenees. The London convent owed its foundation to the liberality of William Marshall, Earl of Pembroke, eldest son of the great William Marshall, Protector of the King and his kingdom after the death of John. It enjoyed a long career of prosperity and usefulness until its final dissolution by Henry VIII. in 1544. On the site was built Northumberland House, purchased by the Metropolitan Board of Works in 1874, and now occupied by Northumberland Avenue and the great buildings which flank that thoroughfare.

The second part of the book is an account of the monuments erected to commemorate the death of Queen Eleanor, and the removal of her remains from Harby, near Lincoln, where she died in 1290, to Westminster Abbey. These consist of her tomb in the Abbey, the work of Richard Crandale, and the series of beautiful crosses, of which those at Chepe, Charing (the site now occupied by the statue of Charles I.) Grantham, Stamford, Stony Stratford, Woburn, Dunstable, and St. Albans, have disappeared, while those at Geddington, Northampton, and Waltham survive in a more or less perfect condition. The preparation of this book, with its fine illustrations and copious references to original authorities, was obviously a labour of love, and it forms an interesting addition to the great library of books on Old London.

Kinship and Social Organisation. By Dr. W. H. R. Rivers. Pp. v+96. (London: Constable and Co., Ltd., 1914.) Price 2*s*. 6*d*. net.

DR. RIVERS has made a speciality of the adaptation of the genealogical method to the interpretation of social facts, to which he has devoted much knowledge and hard thinking. In the present collection of lectures delivered at the London School of Economics he uses his special studies of social life in Melanesia to a consideration of the classificatory system, the essential feature of which is the application of its terms, not to single individual persons, but to classes of relatives which may often be very large. The discovery of this system was the work of Lewis Morgan, who, diverting his attention from the facts at his disposal, attempted to formulate a condition of general promiscuity developing into group marriage, a view offensive to his readers and certain to meet with active criticism. His first opponent was J. F. McLennan, who urged that the terms used formed merely a code of courtesies and forms of ceremonial address for social intercourse. Another theory, that of Prof. Kroeber, suggested that the use of these forms does not depend upon social causes, but that they were conditioned by causes purely linguistic and psychological.

Dr. Rivers, after a careful analysis of the facts, has little difficulty in disposing of these theories. He shows that the process of determination of the nomenclature of relationship by social conditions has been rigorous and exact; further, that every detail of these systems has been so determined. "Even so small and apparently insignificant a feature as the classing of the sister-in-law with the sister has been found to lead back to a definite social condition arising out of the regulation of marriage and of sexual relations." The lectures form a useful contribution to the study of the history of human marriage.

The Farm Woodlot: a Handbook of Forestry for the Farmer and the Student in Agriculture. By E. G. Cheyney and Prof. J. P. Wentling. Pp. xii+343. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 6*s*. 6*d*. net.

THIS is an excellent handbook of elementary forestry, specially adapted for the use of farmers and students of agriculture in North America, yet containing much that should be of interest to landowners in this country. There are well-written chapters on practical sylviculture, on forest mensuration, protection and utilisation, on ornamental planting, and about the durability and preservation of timber. A special article deals with the economic position of the forest and the work of afforestation in the modern State. The authors discuss the question of the apportionment of the soil of a country into the two classes of agricultural and forest lands, on the only just basis; a comparison of the net revenues obtainable from the land under other crops, and under trees. Most of us, who regard the United States as producing timber only from her virgin forests, will learn with surprise that already in New England plantations of white pine have yielded six per cent. annually on the investment.

Another chapter is devoted to the history of the forests of Germany, the United States, and Canada. It is satisfactory to hear that although the progress of scientific forestry in Canada has been slow, and dotted with many set-backs, the prospect at present is promising. In the United States the Forest Service has long been at work, and is now carrying out on the extensive territory under its jurisdiction a magnificent programme, in which the question of profit is never forgotten, all its measures being governed by business principles, none of them by sentiment.

Matriculation Mechanics. By Dr. William Briggs and Prof. G. H. Bryan. Third edition. Pp. viii+363. (London: W. B. Clive, University Tutorial Press, Ltd., 1914.) Price 3*s*. 6*d*.

ADVANTAGE has been taken of the publication of a new edition of this well-known class book to add a collection of simple experiments to illustrate the fundamental principles of mechanics. This addition will certainly increase the usefulness of the book.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Renunciation of Honorary Degrees.

I HAPPEN to see in one of the Dutch journals that a number of German men of science have divested themselves of honours bestowed upon them by British universities and learned societies, on account of the war between England and Germany.

Will you allow me to express the hope, by means of this letter, that my British friends will not reciprocate this action by a similar one?

To my mind, worse than the young lives sacrificed, worse than the destruction of ancient monuments of arts and science, is the almost inevitable consequence of this terrible war: the sowing of hatred and distrust between different nations.

Now it is my firm belief that it is the duty and the privilege of scientific men all the world over to do all in their power gradually to allay these feelings of hatred and distrust.

For this reason especially I regret greatly the action of the German "savants," and earnestly pray my British friends to abstain from similar action.

J. P. LOTSY.

Perpetual Secretary of the Dutch Society of Sciences, Haarlem, September 12.

The Green Flash.

As the green flash continues to appear in your columns, may I give some limiting observations. At sea I have always seen it, if the horizon is clear and not too red. It is also well seen over distant mountains in Egypt at rising, when the sky is less red than at setting. The horizon may be as near as two miles, and still show traces of a green edge. At any distance less than five miles the disappearance can be followed up for some seconds by walking up a slope, so as to keep the green edge under continuous observation.

W. M. FLINDERS PETRIE.

The Large Non-Conchoidal Fracture-Surfaces of Early Flint Implements.

WHEN a representative series of flint implements is examined comprising examples of every stage of culture from the Neolithic back to the earliest Chelles-Palæolithic specimens, it will be observed that, generally speaking, the older the implements the less they show small and "dilettante" flaking in their manufacture, and that when the earliest Chelles stage is reached the flints have been fashioned by the removal of large, bold flakes not supplemented by secondary work, such as is to be seen upon nearly all the examples of later cultures.

When a further series of implements is examined which predate the earliest Palæolithic specimens, this peculiarity is seen to be still more marked, the flints in many cases having been fashioned solely by "quartering" blows producing clean, flat fracture-surfaces exhibiting neither well-marked cones of percussion nor conchoidal rippling, such as are so often produced by the more ordinary type of blow. If, as often happened in pre-Palæolithic times, an implement was produced by means of such blows, the flakes would not in the first place exhibit the normal characteristics of human blows, and secondly, many of these flakes would, in the process of manufacturing the implement, of necessity be truncated and their resemblance to accepted "human" flakes made still smaller. Some of these truncated flakes, moreover, at first sight have the appearance of being thermal breaks, and it requires a close and intelligent examination of their surfaces with a high-power lens to discern those small indications which demonstrate that the flakes have been removed by blows. In addition to the cone of percussion and conchoidal rippling which are often produced by a blow upon a flint, *fissures* of varying size are also formed which radiate from the point of impact.

Some of these fissures, which appear to me to represent "tears" made in the flint by the cleaving force of the blow, are very minute, but in nearly every case are capable of discernment with a really good lens. I have found by experiment that the "quartering" blow to which I have referred, though not producing a well-marked cone of percussion, and very frequently no conchoidal rippling, nevertheless gives rise to these small fissures, and that it is generally possible by the evidence they afford to determine the exact "fracturing agent" and the direction in which it has acted.

It seems to me to be necessary for the prehistorian to recognise the real meaning of these peculiar fracture-surfaces of early flint implements, and I think their non-recognition has been the cause of the inability of many observers to accept these specimens as having been humanly fashioned. To those, however, who are familiar with the method of production of such fracture-surfaces it becomes clear that great precision and dexterity are needed to make an implement by means of this particular type of blow, and that in consequence the probability of unguided natural forces having produced them is practically eliminated.

J. REID MOIR.

12 St. Edmund's Road, Ipswich, September 12.

BRITISH AERONAUTICS.[1]

THE fact that methods of experiment and the apparatus used for test have become standardised has rendered it possible to add considerably to the detailed knowledge relating to aeronautics, and the result is reflected in the increased size of the annual volume published by the Advisory Committee for Aeronautics. The amount of test-work still called for is enormous, and for some time to come problems will need to be taken in order of urgency, whilst many problems of great scientific interest are left for later consideration. Amongst such problems may be classed the mathematical investigation of motion such as that illustrated in Fig. 1, which shows a photograph of fluid motion round a model of an aeroplane wing. The photograph had a time-exposure of about one second, and the lines indicate the direction of the flow, and their length the mean velocity. So far no promising hydrodynamical analysis has been found for such a flow.

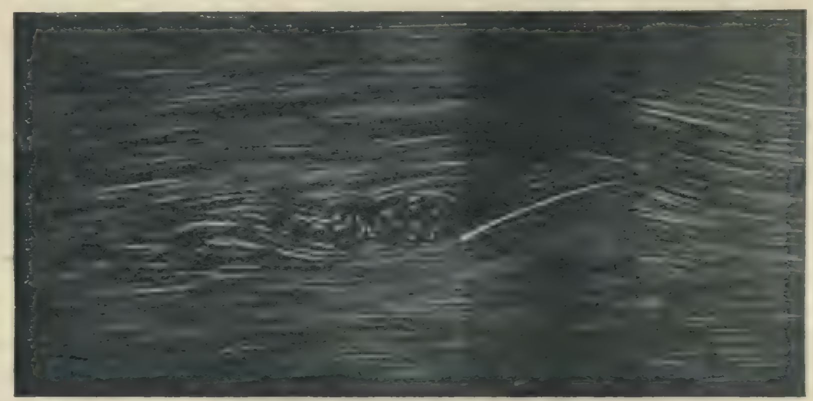

FIG. 1.—Flow round aerofoil inclined at 16°. From "Technical Report of the Advisory Committee for Aeronautics for the Year 1912–13." By permission of the Controller of H.M. Stationery Office.

The report deals with quite different subjects, and relates almost entirely to the experimental determination of the forces and couples acting on models immersed in a moving fluid. A considerable range is covered in relation to parts of aeroplanes, and it is now possible to make a good prediction of the resistance of a new flying machine from the resistances of its component parts. One section of the report shows how model results are applied to full-scale work at the Royal Aircraft Factory.

The report is concerned, on the model side, almost entirely with results obtained in the new four-foot channel at the National Physical Laboratory. The original channel, although very useful, was not considered to be satisfactory apparatus for the permanent equipment, and a series of experiments on model channels and buildings was undertaken in order to find, if possible, some design for a channel which would lead to improved steadiness of air-flow. The production of such a channel proved to be very difficult, and the more important of these difficulties are illustrated by records of fluctuations obtained. A satisfactory design was ultimately obtained and put to a full-scale test in the new four-foot channel shown in Fig. 2. The results of this final test were considered to be quite satisfactory, and since that time a three-foot channel has been erected and put into use, whilst a seven-foot channel to the same general design is nearly completed. An almost exact copy of the four-foot channel has been erected at Boston, U.S.A.

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[1] "The Technical Report of the Advisory Committee for Aeronautics for the year 1912–13." Pp. 416. (London: Wyman and Sons, Ltd., 1914. Price 10s.

From the figure it will be seen that the channel consists of a square trunk, the part from the left to the centre being the working section in which uniform flow is required. The fan is four-bladed and similar to an aeroplane propeller, and is situated in the short circular section to be seen just past the steps. This propeller draws air at speeds up to 50 ft. per sec. through the bell-mouth and a honeycomb, past the model, and through a second honeycomb, finally delivering the air into the perforated chamber or distributor seen to the right of the picture. The air leaves the distributor at speeds less than 3 ft. per sec., and the disturbance of the air cannot easily be detected except within a foot or so of the perforations. The first honeycomb has a use not readily suspected; miniature whirlwinds form on the floor of the building, and unless broken up by a honeycomb, the result on the model is a succession of blows at uncertain intervals. The movement of large bodies of air without the production of vortices is the great problem in the production of a steady wind-channel.

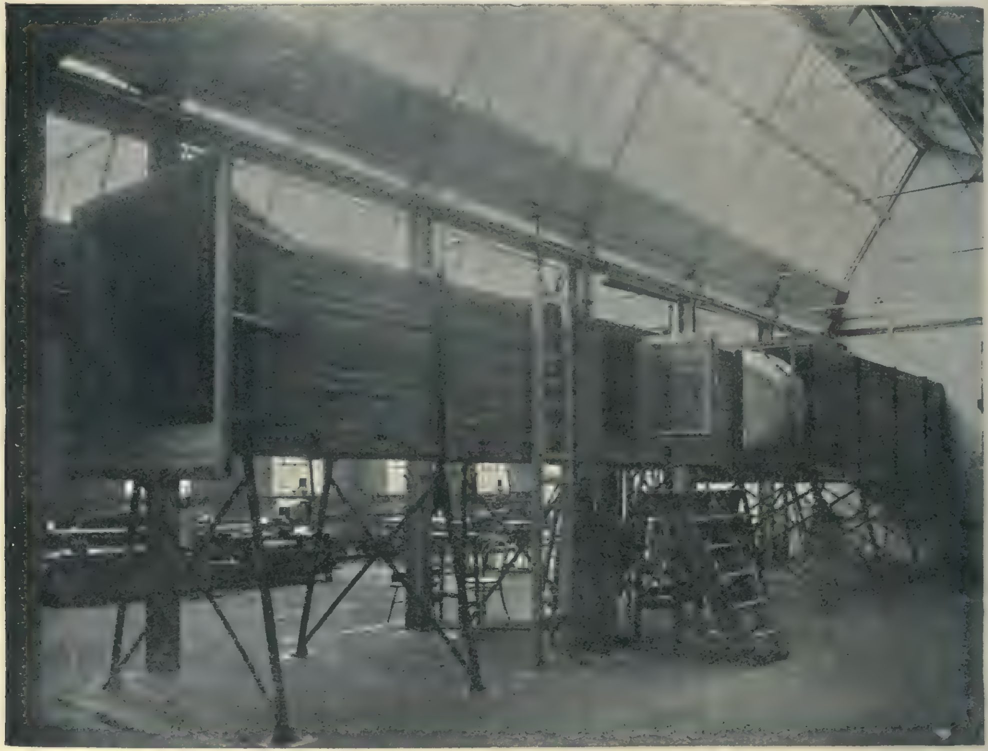

FIG. 2.—General view of the new four-foot wide channel, showing trumpet intake, working section of the channel, and distributor. From "Technical Report of the Advisory Committee for Aeronautics for the year 1912–13." By permission of the Controller of H. M. Stationery Office.

Not only has the air-flow been rendered satisfactory, but the aerodynamic balance has been redesigned and rendered suitable for work of the most general description. It is possible, and has, in fact, become part of the regular work of the National Physical Laboratory, to measure all the forces and couples acting on any body, however unsymmetrically placed on the wind. The precautions taken in the setting of the balance are described in some detail in the report, and show that considerable care is essential to success; the order of accuracy required can be realised from the fact that to obtain the resistance of an aeroplane wing correct to 1 per cent. the wind-direction must be known to within 0·05° relative to the arms of the balance.

There is one measurement other than those provided by the balance which is necessary before the results can be expressed in absolute units, viz. the velocity of the air-current. Experiments have been carried out on the whirling arm of the National Physical Laboratory, from which it has been possible to fix the constant of a standard anemometer to 0·1 per cent., an accuracy which makes the uncertainty in absolute value far less than the errors of observation in most experiments for aeronautical purposes. The accuracy of aeronautical experimental work is often limited by the effects of apparatus for holding the models, and one of the recurring difficulties is that of reducing such interferences until they are small enough to be dealt with as corrections.

Almost all the numerical data given in the section relating to full-scale machines are derived from the results of experiments on models in a wind-channel. Care is necessary in making the application, and the report contains a comparison between tests on model and full-scale wings. The law of dynamical similarity indicates the possibility of a difference, and although the experimental results are not all that could be desired, they furnish a first approximation to one of a series of scale correction factors.

As a result of model experiments it is now possible to try full-scale experiments of a somewhat detailed character.

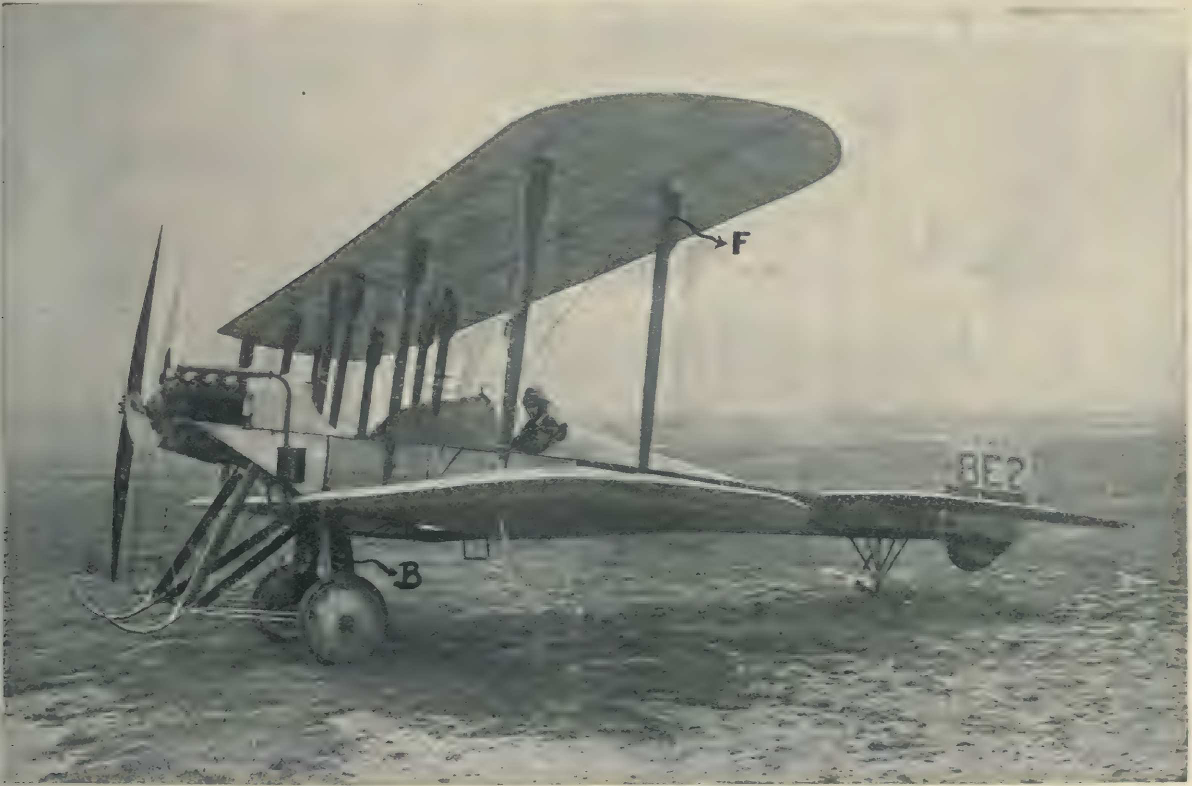

FIG. 3.—BE2 showing fin experiment F and buffer landing gear B. From "Technical Report of the Advisory Committee for Aeronautics for the Year 1912–13." By permission of the Controller of H.M. Stationery Office.

The test illustrated in Fig. 3 relates to the automatic banking of a flying machine, and the detail changed is the upper end of the wing struts. These had been shown by model experiments to become effective fins and therefore suitable for such an experiment.

For measurements of the resistance of hydroaeroplane floats apparatus must be used in which the surface waves can be reproduced, and work of this character is carried out in the William Froude National Tank. The report gives drawings and the results of experiments for a new type of float having a low resistance.

Other parts of the report deal with calculations of the stresses in the wings of aeroplanes, both in the internal structure and in the fabric. Systematic investigation of the strength and extensibility of fabric used for aeroplane covering is in progress. The report generally gives detailed descriptions of each of the tests, the results being expressed in many cases in the form of curves.

THE BRITISH ASSOCIATION IN WEST AUSTRALIA.

PERTH, AUGUST 4.

THE Australian meeting of the British Association has already been very successfully inaugurated, to-day being the last spent by the advance party in Western Australia and the first of the main party travelling by the *Orvieto.*

The Western Australian delegation, numbering close on seventy visitors, has remained a week in the Western State, and this time has been devoted almost entirely to practical work in the country and on the sea. The Western Australian committee from the very first aimed at giving the guests a full week of collecting and investigating, and consequently receptions, garden parties, etc., have been strongly suppressed. That this has been a huge success is evident from the opinions of the visiting men of science, who consider their week of research in Western Australia has amply repaid them for their long journey from England. No meetings of sections have been held whatever. A number of visitors, chiefly botanists, zoologists, and geologists, arrived early in July in order to spend two, or even three, weeks in the State ending with the official week. The official party arrived by the *Ascanius* on July 28 and the P. and O. mailboat of the same date.

Hospitality had been previously found for all the visitors, and the Government of Western Australia had provided funds for official excursions during the week for the botanists, zoologists, and geologists, together with free railway passes over the State railways.

A very well illustrated handbook had also been printed, and was distributed to the guests on arrival. This handbook is on somewhat different lines from those of the other State handbooks, the articles being chiefly on the sciences represented by the visitors. The various sections include a general introduction by the Hon. W. Kingsmill (chairman of the executive committee in Western Australia); agriculture and climate, by W. Catton Grasby; botany, by C. Andrews and Mrs. C. M. G. Dakin; geology, by A. Gibb Maitland; mineralogy and mining, by A. Montgomery; and zoology, by Prof. W. J. Dakin and W. B. Alexander.

On the day of arrival of the visitors Sir Harry Barron, the Governor of Western Australia, held a reception at which about 2,500 guests were present. The first British Association evening discourse was given the same evening by Prof. Herdman, the title being "Why we Investigate the Ocean," and was very largely attended. Three other lectures have been given in Perth during the week and one in Kalgoorlie. The subjects of the Perth lectures were, "Stars and their Movements," by Prof. Eddington; "The Primitive Methods of Making Fire," by Mr. H. Balfour; and "The Electrical Action of the Heart," by Dr. Waller. The Kalgoorlie lecture by Mr. Buckmaster was on mining education in England.

The excursion parties left Perth on Wednesday morning, the day after arrival, with the exception of a small party of keen geologists which started away under the leadership of Prof. Woolnough, of the University of Western Australia, on the previous day.

Prof. W. J. Dakin, one of the local secretaries for the Western Australia meeting, conducted a large party of zoologists to the famous Yallingup and Margaret River caves, situated near the coast in the south-western corner of the State. This expedition, favoured by remarkably fine weather (exceptional for the season of the year), afforded not only a glimpse of the south-west region, where rain is abundant and the vegetation has many peculiar characters, but enabled the zoologists to visit the deposits where such excellent discoveries of fossil giant marsupials have lately been made by the Western Australian museum staff. These investigations have been carried out through the munificence of Sir Winthrop Hackett by Mr. Glauert. The remains include bones of two species of diprotodon, the Tasmanian wolf (*Thylacinus cynocephalus*), the Tasmanian devil (*Sarcophilus harrisi*), a giant Echidna (*Zaglossus hacketti*), and a giant kangaroo. Space forbids a description of the cave formations—the caves are water-formed chambers in a soft limestone which is due itself to the action of atmospheric agents on great accumulations of drift sand. The second large zoological excursion was a motor run from Perth to Mundaring Weir. A hunt was made for arthropods, the greatest interest centring, of course, round Peripatus. About seventy-five living specimens of the latter (*Peripatoides gilesii*) were collected by the party in a few hours. This excursion was also under the leadership of Prof. Dakin.

The zoologists completed their investigations by a dredging expedition on almost virgin ground, turning up many species new to Western Australia.

The botanists were extremely enthusiastic, and well they might be, for Western Australia is without doubt the pre-eminent State as a "botanist's paradise." To quote the words of Mr. C. Andrews, who was leader of all the botanical excursions, "Nearly four thousand species have already been described, and of the four thousand species about two-thirds are endemic."

The botanists commenced work with an excursion to the Darling Ranges, which occupied a full day. On the following day a longer excursion was made, and the party visited a sand-plain district, making their headquarters at the Benedictine Monastery at New Norcia. The third excursion took the party to the interesting Albany district, where, amongst other plants, the famous Cephalotus (the Western Australian pitcher plant) lives. The most interesting plant collected here was Phylloglossum, but very large collections of the Proteaceæ and other characteristic plants were made.

The geologists had a most strenuous week, especially since some of them had put in a hard week immediately before, for the two official excursions covered a fortnight altogether. The first visitors left Perth for Mingenew (two hundred miles north), and spent three days travelling through the Irwin River Valley and examining the Permo-Carboniferous Glacial beds, Marine beds, and Coal Measures. Two more days were employed in excursions in the vicinity of Perth, and the visitors left for Albany on Monday night (July 27). On the following day the geologists of the main Western Australia party arrived and proceeded to Mount Barker (three hundred miles south), meeting the others at that place. The whole party, under the guidance of Mr. H. P. Woodward, acting Government geologist, motored to the remarkable quartzite mountains of the Stirling Range. The last few days were spent in and about the goldfields.

In completing an account of the week in

Western Australia mention must be made of the excellent arrangements for those visitors who were desirous of seeing as much as possible of the State but were not taking the official botanical, geological, and zoological excursions. Mr. Catton Grasby piloted Mr. Golding round the agricultural districts. Mr. Kingsmill and Mr. Battye arranged a week's programme of short local excursions. The Government very kindly arranged a particularly interesting excursion to the timber district at Big Brook and ran a special train, the Premier himself making one of the party. Prof. Ross guided a number of visitors over the wireless telegraphic station, and Prof. Whitfeld conducted a small party to Kalgoorlie.

Special arrangements were made for the overseas party travelling by the *Orvieto* and only having a few hours in Western Australia. The Mayor of Perth entertained the party to luncheon, after motor drives had been taken round Perth. This completed the official visit to Western Australia. Whilst this is being written upon the *Orvieto en route* for Adelaide the party is anxiously waiting for news of the trouble at home, a few tragic rumours having just reached us as we left Perth for the steamer. W. J. DAKIN.

DR. W. H. GASKELL, F.R.S.

DR. GASKELL'S unexpected death comes as a shock to his many friends. A few weeks ago he was in full enjoyment of life. His sixty-seven years were lightly borne, and the ailments inseparable from his years had little effect on his buoyant nature. He was actively engaged in putting in book form his views on the sympathetic system, and no one doubted that he had years of barely abated vigour before him. He died on September 7 after a short illness.

Gaskell entered Trinity College, Cambridge. In 1869 he was placed among the Wranglers in the Mathematical Tripos, and in 1872 he took honours in the Natural Science Tripos. He proceeded to a medical degree, and under the influence of Michael Foster began research in physiology. Carl Ludwig's laboratory in Leipzig was the principal centre of physiological research, and Gaskell went to Leipzig. Under Ludwig's direction he investigated the vaso-dilator fibres of muscle. The resultant paper is one of the classical works on the subject.

On returning to Cambridge Gaskell took up the study of the mechanism by which the several parts of the heart are coordinated in the sequence of contractions which make up the heart-beat. At this time the dominant—though not unquestioned—theory referred the sequence of contractions to the activity of separate groups of motor and inhibitory nerve-cells placed in the heart itself. Gaskell at first supported this hypothesis with certain modifications, but as the result of later investigations chiefly on the heart of the tortoise, he substituted for it the theory, now almost universally adopted, that the conduction of impulses from one part of the heart to the next is by means of a specialised muscular tissue. At approximately the same time Engelmann contested the theory of nervous control, and the modern views of the mechanism of the heart-beat are inseparably connected with the names of Gaskell and Engelmann. Gaskell's work was full of new and important observations. Thus he described how, by lowering the conductivity of the tissue between the auricle and the ventricle, the ventricle only responded to every second and third contraction of the auricle. On the invention of the string galvanometer by Einthoven, the "heart-block," described by Gaskell, explained certain irregularities observed in the cardiac tracings of man, and became of fundamental clinical importance.

In connection with the foregoing work, Gaskell investigated the extrinsic nervous supply of the heart, *i.e.* its innervation by the vagus and sympathetic nerves. He was thus led to his next great line of work, that on the sympathetic nervous system. On this question there were a vast number of observations, but for the most part they were disconnected, and few generalised statements had any currency. A distinction of white and grey rami connecting in the mammal the spinal nerves with the sympathetic had long been known, and Onodi and others had described the absence of white rami in the cervical, lower lumbar, and sacral regions. The white rami were known to be composed chiefly of myelinated nerves and the grey rami of non-myelinated nerves. Gaskell's observations were chiefly microscopical. He noted that the roots of the spinal nerves at their origin from the spinal cord had no non-myelinated nerve fibres, and from this and other facts he deduced as a broad general statement that the outflow of nerve fibres from the spinal cord to the sympathetic chain took place solely, or almost solely, in the regions in which white rami were present, *i.e.* in the thoracic and upper lumbar regions. In Gaskell's paper there are other generalisations with regard to the sympathetic and allied nervous systems, but it would take too much space to discuss them here. It must suffice to say that Gaskell was the first to attempt to treat the innervation of the blood-vessels and the viscera in a comprehensive manner.

Gaskell's study of the relation of the central nervous system to the sympathetic nervous system in vertebrates led him to consider the relation of both to the nervous system of invertebrates, and he passed from the more special domain of physiology to that of morphology. He arrived at conclusions differing essentially from that held by morphologists, and the remaining years of his life were mainly occupied in advocating his views and working them out in detail.

Taking Gaskell's work as a whole, it appears that the main bent of his mind was for generalisation. It was scarcely possible for him to make an experiment without extending the conclusions to be derived from it to a number of other phenomena. It was both his virtue and his defect. His influence on physiological conceptions has been widespread, and it will be long before he ceases to be a living force and passes to the position—honourable as it is—of an historical figure in physiological science.

Gaskell cared little for public ceremonies, and rarely attended the congresses which beset the path of prominent scientific men. He loved to work quietly, to cultivate his garden, to see his friends, and to take a hand at whist or bridge. His house at Great Shelford was a recognised meeting-place for physiologists, and his frank and genial welcome will be an abiding recollection to all who knew him. J. N. LANGLEY.

NOTES.

WE learn from a paragraph in the *Times* of September 19 that the question of abandoning honorary degrees received from English universities, and distinctions from learned societies, is being discussed by some German professors. Prof. W. Förster, professor of astronomy in the University of Berlin, who holds a doctor's degree at Oxford, takes objection to the movement in a letter to the *Berliner Tageblatt*, on the ground that it is unwise to proclaim a divorce from the "learned world" of England because of England's "wicked policy." It would be better for the German professors to make a strong appeal to their English friends for "a more effective loyalty to the intellectual community." Protests against Prof. Förster's views promptly came from Profs. Eucken and J. Kohler, who hold chairs of philosophy and law respectively. In connection with this question we are glad to print elsewhere in this issue a letter from Dr. J. P. Lotsy asking scientific men who have received honours from universities, or other learned institutions of nations with which their own countries are at war, not to commit the act of renunciation advocated by certain representatives of German learning.

WE are glad to see in Tuesday's *Times* a letter from Prof. J. A. Fleming dissociating scientific work from the spirit of Prussian militarism. In the course of his letter, Prof. Fleming says:—"No one familiar with the achievements of scientific thought would refuse to admit the indebtedness of the world to such thinkers and workers as Jacobi, Gauss, Bessel, Riemann, H. F. Weber, von Helmholtz, Kirchhoff, Hertz, and Röntgen, but the fact is quite as astonishing as it is painful that a nation which has made such contributions to the upbuilding of natural philosophy should have permitted itself also to be dominated by an immoral militarism by whose votaries sheer brute force is worshipped as the highest virtue and the only source of national advancement. Side by side with immense ability in creating and applying scientific knowledge we have an almost complete failure to recognise truth, honour, faith-keeping, and justice as the foundations of national greatness. Germany has no greater need at the present moment than some inspired prophet to enforce on her the truths of which Thomas Carlyle was so eloquent an exponent—namely, that physical force is in the long run impotent unless backed by those spiritual forces which spring only from loyalty to the everlasting difference between right and wrong."

WE learn with regret that Dr. H. J. Johnston-Lavis, professor of vulcanology in the Royal University of Naples, was killed in a motor accident at Bourges early this month.

WE regret to announce the death of Sir Henry G. Howse, at one time senior surgeon to Guy's Hospital, and president of the Royal College of Surgeons, England. He was eminently a practical surgeon, making numerous contributions to the medical literature of his time. Some years ago he retired from active practice, and settled near Sevenoaks, Kent, where he enjoyed a well-earned leisure. He was in his seventy-third year.

THE death is announced at Louth, Lincs., of Mr. George Gresswell, formerly lecturer in physical science, under the Government of the Cape of Good Hope, at the Diocesan College, Rondebosch, and demonstrator of practical physiology and histology at Westminster Hospital. Mr. Gresswell was the author of a number of books and papers, including several on the theory of evolution.

FROM telegraphic messages issued through Reuter's Agency we learn that the United States Revenue cutter *Bear* on September 8 rescued eight members of Mr. Stefánsson's Canadian Arctic Expedition, who were marooned on Wrangel Island. It is reported that Mr. Mallock, the geologist, and Mr. Mamen, the topographer to the expedition, died on Wrangel Island. The absence of news leads to the fear that M. H. Blanchet, of Paris, Dr. A. Mackay, and Mr. James Murray, other members of the expedition, may have been lost. Mr. Stefánsson himself and three others are said to be safe and to be drifting towards King William Land.

SIR ERNEST SHACKLETON and the members of the Trans-Antarctic Expedition left London on September 18. Those members of the expedition proceeding to the Ross Sea travelled *viâ* Tilbury for Tasmania; the others, the Weddell Sea section, included Sir Ernest Shackleton, and embarked for South America. The Ross Sea party expects to sail from Hobart in the *Aurora*. The Weddell Sea contingent hopes to leave Buenos Aires on October 18 by the *Endurance*. After landing its party the *Endurance* will return to the Falkland Islands, whence news of the explorers may be expected next January. If Sir Ernest Shackleton's land party does not cross the Antarctic Continent during the first season it has been arranged that the *Aurora* shall winter in the Ross Sea. Sir Ernest Shackleton hopes to meet the Ross Sea party either in April of next year, or, failing that, in March, 1916.

UNIVERSITY COLLEGE, Galway, has, during the summer vacation, suffered a great loss by the death of Prof. R. J. Anderson, professor of natural history in the college. Dr. Anderson was greatly beloved by his colleagues and his students. He was a genuine scholar, with few interests outside the world of science. With his wife (a sister of Prof. John Perry, of South Kensington) he was a constant attendant at the meetings of the British Association and the British Medical Association. He graduated in the Queen's University of Ireland, and afterwards studied at London, Leipzig, Paris, Heidelberg, and Naples. For eight years he was lecturer on anatomy and assistant professor of physiology in Queen's College, Belfast, and for more than twenty-five years he occupied the chair of natural history in Galway. He was co-editor of the *International Journal of Anatomy and Physiology*; was an honorary president at Lisbon Medical Congress, Sec. Intermediate I.; an honorary president at Buda Pesth Medical Congress, Sect. Board II.; a vice-president Anatomical Section, British Medical Association, at Glasgow. He made a speciality in his studies of vertebræ skeleton and mammalian morphology. His published works include "The Elephants" (1895), "The Whales and Dolphins" (1896), "Chelonia" (1912), and "German Influence: Intellectual and Moral" (1896). Dr. Anderson graduated M.A. with the highest honours in the Queen's University, and at the examination for the M.D. degree of that University he obtained first place, the Peel scholarship, and a gold medal. He was a member of the Royal College of Surgeons (England).

IN *Man* for August Dr. S. N. Shannus describes a form of iron-smelting furnace used by the Angonis of Nyasaland. The furnace is about 10 ft. in height, bottle-shaped, and made of clay, supported by wooden poles let into the ground, bound round the outside. At the base there are eight holes through which earthenware pipes having an internal diameter of 3 in. are inserted to create the draught. The furnace is built on a slight slope, which allows of a hole being made at the lower side from which the slag escapes. A rough platform of logs is made up against the upper side for the convenience of those filling the furnace. It is filled almost to the neck with charcoal, which is ignited from the top, and a mixture of charcoal and iron-stone in equal proportions is added at intervals. The operation lasts for two days, when an opening is made at the base of the furnace, and the iron, which has collected in a circular trough at the bottom, is extracted.

MR. A. D. PASSMORE discusses in *Man* for August the reason for the absence of large flint implements in Gloucestershire. In this district there is no indigenous flint, and the raw material was probably imported from Wiltshire. In Wiltshire, where flint is common, a man who broke a large axe could afford to throw the pieces away and pick up a fresh lump to replace it. But in Gloucestershire the reverse would be the case, and the pieces would immediately be used up to make arrowheads, scrapers, and the like. At Windmill Hill, near Avebury, Wilts, flakes and pieces of flint which were once obviously parts of axes have been found in great numbers. It has been supposed, in order to explain this fact, that a successful invading race of bronze-using people went round after the conquest smashing up the flint weapons of their victims. This is, he thinks, more probably due to the fact that working material of tried value was used in preference to that which was not tried, and the fragments were the waste remaining after the conversion of broken implements into smaller articles. As a parallel, he quotes the case of a repairer of old furniture using an old table-top which bore a peculiar yellow polish, with the result that small pieces bearing this peculiar polish could be picked up in all corners of the workshop.

IN the report of the Otago University Museum for 1913 it is recorded that considerable additions have been made to the Hocken library, the principal contributors being Mrs. Hocken herself and Mr. Trimble. The curator laments that school teachers neglect the opportunities offered by the museum for instruction in nature-study.

ACCORDING to the report for the year ending June 30, 1914, the most important recent addition to the natural section of the Warrington Museum is the herbarium of the late Mr. W. Hodge, of Northwich, which was acquired by purchase. It includes 931 sheets of flowering plants, representing 824 species, and 121 sheets, with 115 species, of mosses, together with five volumes of notes. Nearly half the specimens were collected locally.

THE biology of humble-bees and honey-bees and the various forms of cells constructed by different kinds of wasps are discussed by Mr. O. J. Lie-Pettersen in the combined July and August number of *Naturen*. Another article on bees appears in the August issue of the Proceedings of the Philadelphia Academy, in which the author, Dr. N. E. McIndoo, describes the scent-producing organ of these insects. This organ, situated between the fifth and sixth abdominal segments, is furnished with gland-cells, which were long considered to be for the purpose of secreting perspiration, but their true function was pointed out by Sladen in 1902. Apparently these glands secrete a volatile substance, which collects in a special reservoir (ampulla), whence it passes through a chitinous tube to a canal on the dorsal surface of the abdomen. So long as the abdomen remains straight, the canal is well protected, and the liquid can only evaporate slowly; but directly this part of the body is strongly flexed, the entire canal is more or less fully exposed to the air, in which the odour of the evaporating fluid becomes rapidly diffused.

A GEOLOGICAL map of Nova Scotia in one sheet, on the scale of one inch to eight miles, has been issued by the Geological Survey of Canada. The Palæozoic sequence is remarkably complete. While the crystalline rocks of Cape Breton Island are clearly pre-Cambrian, a Devonian granite is prominent in the south-west of the country, where it forms the watershed. North-west of it, the coastline of the Bay of Fundy is moulded on the strike of a long band of Triassic dolerite.

DR. F. R. VON HUENE, of Tübingen, summarises the conclusions of his recent work on Dinosaurs in the *American Journal of Science*, vol. xxxviii. (1914), p. 145. He urges that the dinosaurs are not a natural order, and that Seeley's two divisions, the Saurischia (=Theropoda+Sauropoda) and Ornithischia (=Orthopoda), were separately derived from the Pseudosuchia. References are given to his three papers published in Germany in the present year.

THE production of amphibolites, rocks rich in hornblende, felspar, lime-garnet, etc., through the alteration of limestone invaded by a granitic magma, presents features of chemical as well as geological interest. A notable addition to the work done in France, Canada, and elsewhere is made by P. P. Sustschinsky (*Trav. Soc. imp. Naturalistes St. Pétersbourg*, vol. xxxvi., livr. v.), who illustrates a number of examples of contact-alteration from south-west Finland. A German summary is provided.

THE memoir of the Geological Survey of England and Wales on the geology of the northern part of the Derbyshire coalfield (price 3*s*.), by W. Gibson, C. B. Wedd, G. W. Lamplugh, and others, will be of interest to many besides professed geologists. The area includes Matlock and the famous Creswell Caves, rich in Pleistocene mammalia, and excellent photographs are given of this land of limestone crags. L. Moysey contributes classified lists of Coal-Measure fossils, occupying twenty-two pages, which will be of service to workers throughout central England.

THE stratigraphy of New Zealand has been so retarded, and, it may be added, confused, by the imperfection of the palæontological data, that we welcome the Palæontological Bulletin No. 1, issued by the New Zealand Geological Survey. In this quarto memoir, J. A. Thomson brings together materials for the palæontology of New Zealand, including a list, with references, of all the known pre-Cretaceous fossil species of the country. Plates that have been long in stock are now issued with this publication. We note what is perhaps an appeal to a new group of helpers in national scientific work in the addition of Maori names for the islands, and for New Zealand itself, in the two topographical maps that are so well provided.

So much interest has been attracted to the antarctic regions that it may be well to mention a paper published in the *Cairo Scientific Journal*, vol. viii. (1914), p. 77, by H. T. Ferrar, who accompanied the *Discovery* in 1901. The summary of geological conclusions indicates the occurrence of both "Atlantic" and "Pacific" types of crust-structure in the antarctic continent. The author urges that the shrinkage of the glaciers is due to decreased precipitation on the higher ground, and that the cause of this is "a general lowering of the temperature of the polar atmosphere." It must be remembered, on the other hand, that ice-sheets may be nourished by small annual precipitation, provided that the conditions are cold enough to reduce the loss by evaporation and ablation. Geographers may overlook this paper in an Egyptian journal, and may also be glad of a reference to a description by W. Bellows, accompanied by a good panoramic photograph, of the rarely seen arctic island of Jan Mayen. This appeared in the Proceedings of the Cotteswold Naturalists' Field Club, vol. xvii., p. 333.

WITHIN less than a year seismology has lost two of its leading students. Prof. Milne died on July 31, 1913, and Prof. G. Mercalli, through fire in his house at Naples, on March 19, 1914. Born on May 21, 1850, and therefore only a few months older than Milne, Mercalli's attention was concentrated at an early age on the study of volcanoes and earthquakes. His first important work was that on the "Vulcani e fenomeni vulcanici in Italia" (1883), which formed the third part of the "Geologia d'Italia" by G. Negri, A. Stoppani, and G. Mercalli. In partnership with Prof. T. Taramelli, who contributed the geological parts of the reports, he studied the Andalusian earthquake of 1884 and the Rivièra (Ligurian) earthquake of 1887. In 1902, he proposed the modification of the Rossi-Forel scale of seismic intensity which now bears his name, and is widely, almost universally, used throughout Italy. As a seismologist, Mercalli will perhaps be remembered chiefly for his contributions to the physiographic side of his science. He prepared a general catalogue of Italian earthquakes from 225 B.C. to A.D. 1859, and the generosity of his disposition is shown by the help which he gave to Dr. Baratta in the work by which this catalogue has now been superseded. One of his earliest detailed studies of earthquakes was that on the destructive Ischian earthquake of 1883; and he has since (1897) published important memoirs on the earthquakes of Liguria and Calabria. Few, if any, of the Italian volcanoes have escaped the attention of Mercalli, but to the Vesuvian phenomena he devoted unremitting study for a period of about twenty years. An admirable summary of his scientific work by Dr. E. Oddone appears in the last *Bollettino* of the Italian Seismological Society (vol. xvii., pp. 245–262).

IN view of the unfortunate interruption to the useful work of the international exploration of the upper air, owing to the war now raging over Europe, it is satisfactory to note that there are several stations in the British Isles at which such observations are regularly made. The annual supplement of the *Geophysical Journal*, 1912, recently published by the Meteorological Office, contains a summary of the records of registering balloon ascents at six stations, and additional data not included in the monthly issues. The results of fifty-two successful ascents were published during the year in question, and it is stated that there was scarcely a single failure in obtaining a trustworthy record up to at least 10 km., but that the year was an unfortunate one in the matter of finding the balloons. The more salient features of each ascent are brought together in one table and expressed in international units, from which, among other interesting results, it is seen that the mean height of the base of the stratosphere was 10 km., and the corresponding temperature 218·5° A. (273° A. = 0° C.); temperature at the mean maximum height reached (14·7 km.) 221°; mean temperature of the air column between 1 and 9 km., 251·8° It should be noted that most of the ascents were made in the summer season. Out of the falling points of the balloons there were twenty-two in the S.E. and fourteen in the S.W. quadrant; the preponderance of falls in the former quadrant agrees with continental observations.

IN the Memoirs of the Indian Meteorological Department (vol. xxi., part ix.), Dr. G. T. Walker publishes a short note on the criterion for the reality of relationships or periodicities. If an attempt is made to correlate a pair of variable quantities there is a certain measure of correlation to be expected even in the absence of any definite relationship. This measure must be sensibly exceeded if the result actually found is to be treated as an indication of causal connection. When, however, a whole set of correlations is determined the fortuitous element will occasionally be largely exceeded without indicating a real relation. Similarly, when a complete periodogram is investigated the largest ordinate must exceed the probable measure by a large factor if the corresponding periodicity is to be regarded with any confidence. The outcome of Dr. Walker's paper is a table giving the ratios of the greatest of an assigned number of (1) accidental correlation coefficients, (2) amplitudes of periodicities, to the probable value of a single one. The note illustrates the need for extreme caution in interpreting the results of work of this kind. But it does not touch the real difficulty of periodogram analysis. This consists, in the language of the optical analogy, in the occurrence of banded spectra. Until this feature becomes amenable to sound interpretation, the periodogram method, always painfully laborious, is likely to remain absolutely sterile.

FROM the recently issued report of the Government Chemist (Cd. 7562) we learn that a large number of determinations of the salinity of sea-water were made last year at the Government Laboratory, for the information of the Permanent International Council dealing with the exploration of the sea. More than four thousand samples of sea-water were taken by steamships on various routes and by lightships round the coast, and forwarded for examination. The data relating to the specimens from the Atlantic routes are published with the monthly charts issued by the Meteorological Office. It is noted in the report that the chemical work of the Geological Survey is in future to be performed by the staff of the Government Laboratory, and arrangements have been made for this purpose. During the year an extensive series of experiments was conducted in connection with the measures to be taken for the preservation of the roof of Westminster Hall; the results are not stated, but a summary of the conclusions arrived at has been published as an appendix to the report of the architect in charge of the work. There is an interesting reference by the Government Chemist to the composition of a series of medieval wax seals, of various dates from the thirteenth to the sixteenth centuries, which were examined for the Record Office. An impression of the Great Seal of 1350 was found to consist of pure beeswax which, although nearly six centuries old, corresponded exactly in properties with wax of recent origin. Among other matters of interest mentioned are some experiments upon the keeping of milk in galvanised-iron vessels: the results showed that at the end of twenty-four hours the milk had dissolved zinc equal to about half a grain per pint, and also traces of antimony and arsenic. There was a large increase in the total number of samples examined last year as compared with the previous year, the respective numbers being 234,754 and 209,502.

PART V. of vol. xxvi. of the Proceedings of the Physical Society of London consists of 114 pages of papers communicated to the society, the index to the volume and the proceedings at meetings of the society during the session 1913–14. Readers of the Proceedings will, we feel sure, cordially welcome the issue of them with their edges cut. It will be noticed that the society has a committee on nomenclature and symbols which makes a provisional report on electric and magnetic symbols in the present number. Communications dealing with electrical subjects show a marked preponderance over those relating to other branches of physics. Of the electrical papers may be mentioned Mr. F. E. Smith's on a variation magnetograph, Mr. F. Mercer's on the arc electric wave generator, Prof. Fleming's on the bending of such waves round the earth, and Sir Joseph Thomson's account of his search for waves still shorter than those hitherto produced. A paper by Mr. T. Barrett deals with the thermal and electric conductivities of rare metals, and one by Prof. Lees with Fourier series and the method of least squares.

PROF. F. C. LEA, of the University of Birmingham, and Mr. O. H. Crowther give an account in *Engineering* for September 18 of some experiments on reinforced concrete beams. In these experiments the longitudinal strains of a part of the beam subjected to uniform bending moment were measured by a special type of extensometer. From the resulting curves, it appears that the ordinary assumption that the distribution of stress is linear on the compression side of the neutral axis is approximately correct. The experiments show also that the modular ratio diminishes as the stress increases, and is slightly higher for the richest mixture than for the poorer mixtures. The evidence so far is opposed to the recent London County Council Regulations, but the authors consider that it is desirable that the experiments should be continued, and have made arrangements for this to be done.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—It is announced that a bright comet was discovered at the Cape Observatory on September 18. The comet was then near the star Achernar (α Eridani), and therefore invisible in the British Isles.

COMET 1913*f* (DELAVAN).—Comet Delavan is now beginning to diminish more rapidly its northern declination, but is still a circumpolar object, and therefore visible throughout the whole night. It is a conspicuous object to the naked eye, and lies nearly on the prolongation of a line towards the horizon joining the two pointers (α and β) in Ursa Major. This position can be easily found by consulting the chart given in this column for September 3. The comet is steadily increasing in brightness, and its tail has considerably increased in length. The dark nights recently experienced have been very favourable, both for visual and photographic work, and no doubt a large harvest of data is being collected.

M. Bigourdan, in the *Comptes rendus* for September 7 (tome clix., No. 10), gives some observations for position of this comet which he made at the Paris Observatory on September 2 and 3.

HYDROGEN LINES AND SERIES CONSTANT.—Under the heading "Wave-lengths of Hydrogen Lines and Determination of the Series Constant," Mr. W. E. Curtis recently communicated through Prof. Fowler an important paper to the Royal Society (Roy. Soc. Proc., Series A, vol. xc., No. A 622). The object of the research was first to obtain with the utmost accuracy the wave-lengths of the lines in the Balmer or series spectrum of hydrogen in order to test the formula and make such modifications of it as were considered necessary. Another part of the research restricted itself to the evaluation of the international system of wave-lengths of the constant occurring in the formula; the importance of this constant will be appreciated when it is stated that it may be used in all formulæ representing series of lines. The degree of accuracy which could be obtained with the spectrograph employed (10 ft. concave grating) using the new international standards of wave-length was next investigated. The results of the research are summed up as follows. The wave-lengths in I.A. of the first six lines of the hydrogen series were determined with an accuracy of about 0·001 Å.U. Balmer's formula was found to be inexact and the results could be represented by a modified Rydberg formula containing only two constants. An accuracy of 0·001 Å.U. was attainable in the third order of the grating spectrograph with exposures of less than half an hour. With longer exposures the determination became less accurate owing to the uncontrolled temperature of the instrument. The tertiary iron arc standards determined by Burns were tested in the special regions under investigation and found very satisfactory.

A NOVEL FORM OF ROWLAND GRATING MOUNTING.—Dr. A. S. King, in the Contributions from the Mount Wilson Observatory, No. 84 (*Astrophysical Journal*, vol. xl., 1914), describes a vertical adaptation of the Rowland mounting for a 15-ft. concave grating which has recently been mounted in the Pasadena laboratory of the Mount Wilson Solar Observatory. The general arrangement is as follows:—The plate-holder moves on a horizontal track, at a convenient distance above the floor, supported by a frame of channel iron placed over a slot in the cover of the pit used for the already existing vertical Littrow spectrograph. The slit is at one end of the horizontal track and vertically above the grating, and is contained in a hollow iron casting with a brass collar, which holds the slit tube and permits the adjustment of the height of the slit. The grating is contained in a cast-iron box with an extension which is bolted to the web of a girder connecting with the plate-holder carriage. The grating box is fixed to a carriage which is capable of movement on a vertical track, and an ingenious arrangement is adopted to allow for the variable pull when the grating is being raised by the movement of the plate-holder carriage along the horizontal track. Dr. King describes many interesting details about this variable counterweight system, the plate-holder carriage, photographic plate-holder, etc. While the mounting retains all the good features of the usual Rowland form, there are many distinct advantages. In the first place, there is an excellent temperature control in the pit, the grating and connecting girder benefiting thereby. The mounting requires little floor space, a narrow space against a wall being all that is necessary. No darkening of the room is necessary, and therefore no interference with other work being carried on in the laboratory. For assistance in planning the instrument Dr. King refers to Mr. Pease for designing the main structural features, to Mr. Nichols for numerous devices in convenience of working, and to Mr. Ayers and Mr. Shumway for construction and mounting.

THREE NEW INDIAN METEORITES.—At a meeting of the Asiatic Society of Bengal held on August 5 Mr. Coggin Brown read an interesting account of the fall of meteorites in India which had been described by Mr. C. A. Innes, the acting collector of Malabar. It seems that meteoric stones fell on April 6 last at Kuttayi, Triprangode, Trikanapuram, and Kuttippuram, places in the Pounani taluk of the Malabar district. These places are practically in a straight line, Kuttayi being on the coast and Kuttippuram nine or ten miles easterly from the last-mentioned place. Triprangode is about three miles from Kuttayi, Trikanapuram about five miles from Triprangode, and Kuttippuram about two miles from Trikanapuram. Four small stones are reported from Kuttayi, one from Triprangode, and six from Trikanapuram. One large stone, weighing 71 lb., fell at Kuttippuram, but it is now in three pieces. The account then describes the appearances of the fall at the different stations. As regards the large stone which fell at Kuttippuram, it is stated "the stone fell in a paddy field which was then dry and penetrated some feet into the ground. A cloud of dust rose into the air, and this cloud attracted people to the spot. But they were apparently afraid to touch the stone, and it was not until some hours later that it was dug out, and then it was quite cold. The people who gathered at the spot say that for some minutes after the fall there was a smell of backwater mud in the vicinity. Backwater mud or silt is black, oozy stuff, which is full of rotting organic matter, and its smell, which is familiar to everyone who lives in Malabar, is most unpleasant." The noise of the first two loud reports is said to have been heard at various places in Malabar. It was heard distinctly at Pounani, 4·5 miles from Kuttayi, and was recorded as having been heard at Calicut, a distance of thirty miles north of Kuttayi.

THE LANCASHIRE SEA FISHERIES LABORATORY.[1]

WE have recently received the report for 1913 on the Lancashire Sea Fisheries Laboratory at the University of Liverpool and the Sea Fish Hatchery at Piel, edited by the honorary director of the scientific work, Prof. W. A. Herdman, F.R.S.

It appears that more than one million plaice and twelve million flounders were hatched at Piel and committed to the sea. The usual course of instruction for fishermen was given, and nature-study evening classes were restarted on behalf of the Education Committee of Barrow, both with satisfactory results. In connection with the classes for fishermen, a new edition of the syllabus has been published and brought up to date by Dr. Johnstone, while a section on navigation by Captain Thornber has been included. There is also appended an excellent series of biological photographs by Mr. A. Scott.

Various observations arising out of mackerel investigations by Mr. Scott are given, particularly with regard to the food of the mackerel, and also a report on the distribution and periods of occurrence of pelagic fish eggs. The seventh annual survey of the work on the intensive study of Irish Sea plankton is submitted by the director, together with some observations on the summer plankton of the west coast of Scotland. The records of the work done by Dr. Johnstone in connection with diseases of fishes are incorporated, as is also a continuation of his detailed work on the measurements of plaice, the latter being of particular interest in view of the proposal by the International Fisheries Bureau to impose limits on the size of plaice to be landed. The results of Dr. Johnstone's plaice-marking experiments are also given.

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[1] Report on the Lancashire Sea Fisheries Laboratory for 1913. No. xxii.

Mr. William Riddell continues his hydrographical investigations, and the results of the chemical analyses of the water samples and a dissertation on their import are given by Prof. Bassett. As part of a proposed general scheme of investigation of the British herring races arranged by the Board of Fisheries, several samples of herrings from the Welsh coast and from the Smalls were examined and the measurements are detailed in the report. A paper of a preliminary nature on sea-bottom deposits and fish food off the Lancashire and Cumberland coasts is contributed by Mr. R. Ray. Dr. Johnstone gives a topographical description of the mussel grounds in the Ribble Estuary and several other Welsh beds. From the results of a bacteriologial analysis, also given, much sewage contamination seems to exist at several of the grounds.

Two important papers by Prof. Moore and his collaborators are given on the debated question of the ability of marine animals to subsist on the organic carbon dissolved and in suspension in sea-water. The results seem to prove conclusively that such subsistence for long periods is impossible, and that neither dissolved organic matter nor the average amount of suspended plankton suffices to account for the nutrition of the larger marine organisms.

Several minor reports conclude the survey of the year's work.

THE METROPOLITAN WATER SUPPLY.[1]

THE two reports by Dr. A. C. Houston, director of water examination, recently issued by the Metropolitan Water Board, show how much is now being done to safeguard from contamination with dangerous micro-organisms the metropolitan water supply, which is admittedly largely derived from sewage-polluted sources. The eighth annual report gives the results of the chemical and bacteriological examination of the London waters for the twelve months ended March 31, 1914. In the introduction Dr. Houston points out that experience in the Water Board laboratories indicates that *Bacillus coli* is practically totally absent from pure waters; in ten specially devised experiments with the Twins well (Deptford) water, typical *B. coli* was absent from 10,000 c.c., and it has been abundantly shown that it is possible, at a not impracticable cost, so to purify the raw river waters that the final product contains no typical *B. coli* in 100 c.c. in more than 80 per cent. of the samples.

In the tenth report on research work, the results of several important researches are detailed. The search for the typhoid bacillus and similar micro-organisms in raw river water and crude sewage has been continued, but although a large number of samples has been examined, none has been found. Various methods for the isolation of the typhoid bacillus in these circumstances are reviewed.

A study of the streptococci present in excremental matters has not resulted in finding any definite difference between those present in human, and those present in animal, excrement.

The value of storage as a means of eliminating pathogenic micro-organisms and of lime as a bactericidal agent are further confirmed in series of new experiments.

Altogether these two reports are worthy of careful perusal by public health authorities and bacteriologists, and show how much valuable but unobtrusive work is being done by Dr Houston and his staff.

R. T. HEWLETT.

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[1] Metropolitan Water Board (*a*) "Eighth Annual Report" on the results of the Chemical and Bacteriological Examination of the London Waters for the twelve months ended March 31, 1914. (*b*) "Tenth Report on Research Work." Both by Dr. A. C. Houston, Director of Water Examination, Metropolitan Water Board.

LOCAL CASE-HARDENING OF STEEL.[1]

IN a paper read to the Société d'Encouragement pour l'Industrie National, MM. Guillet and Bernard discuss the various methods employed when it is desired to case-harden steel objects in certain parts only. The methods used are:—

(1) The parts to be protected against cementation are covered with fire-clay. The protection thus furnished is not complete, as the gases penetrate the fire-clay. Also in complex shapes the method becomes complicated and expensive.

(2) A tube is shrunk over the parts to remain uncemented, the thickness of the tube being slightly greater than the depth of case required. After the end of the cementing process, the tube is broken off. This method is obviously very limited in its application.

(3) The object is made with extra thicknesses in those parts which must not be hardened. After cementation and before hardening, these extra thicknesses are machined off. This process is very expensive.

(4) The parts not to be cemented are protected by a metallic deposit which must be (*a*) solid at the cementing temperature, (*b*) impervious to the cementing materials, (*c*) easily obtained commercially, and (*d*) easily removed after the operation. Copper and nickel are the only metals which fulfil conditions (*a*) and (*c*), and the latter fails to comply with condition (*b*).

The metal may be deposited by immersion in a salt solution, by electrolysis, or by the Schoop spraying process. The first mentioned is not satisfactory owing to the thinness and uncertain adherence of the coating. The electrolytic process is cheaper to instal than the spray process, which, on the other hand, is quicker and more easily localised.

The authors also consider the question of diffusion of metals. They show that for this to take place, (1) the two metals must be capable of forming solid solutions with each other, (2) they must be in very good contact, and (3) the temperature must be between the limits at which the solid solution exists. The higher the temperature, the greater is the rate of diffusion. They conclude that the diffusion of solids into solids is a very common phenomenon, which in certain cases (*e.g.* tinned condenser tubes) may introduce very considerable changes into the properties of the metal.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. F. O. BOWER, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

To preside over the botanical section on the occasion of its first meeting in Australia is no slight honour, though it also imposes no small responsibility. We members from Great Britain have a deep sense of the advantage which we derive from visiting these distant shores. I am doubtful whether any scientific profit we can confer by our coming here can balance that which we receive; while over and above this is the personal kindliness of the Australian welcome, which on behalf of the visitors of this section from the Old Country I take this opportunity of gratefully acknowledging. Of the members of the British Association, those who pursue the natural sciences may expect to gain most by their experiences here; and perhaps it is the botanists who stand to come off best of all. Living as most of us do in a country of old cultivation, the vegetation of which has been controlled, transformed, and from the natural floristic point of view almost ruined by the hand of man, it is with delight and expectation that we visit a land not yet spoilt. To those who study Ecology, that branch of the science which regards vegetation collectively as the natural resultant of its external circumstances, the antithesis will come home with special strength, and the opportunity now before them of seeing Nature in her pristine state will not, I am sure, be thrown away.

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[1] Les réserves en cémentation et la diffusion dans les solides." By MM. Léon Guillet and Victor Bernard. *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, vol. cxxi, No. 5. Pp. 588–618.

I may be allowed here to express to the Australian members of the section my regret that the presidency for this occasion should not have fallen to one who could with unusual weight and knowledge have addressed them from the floristic and geographical point of view. I mean, to Professor Bayley Balfour, of Edinburgh, who was actually invited by the Council to preside. He could have handled the subject of your rich and peculiar flora with detailed knowledge; and, with the true Hookerian touch, he would have pictured to you in bold outlines its relation to present problems. Failing such equipment, I may at least claim to have made some of your rare and peculiar forms the subject of special study at intervals spread over thirty years: for it was in 1884 that I was supplied with living plants of Phylloglossum by Baron Ferdinand von Müller, while a paper to be published this year contains details of a number of ferns kindly sent to me by various collectors from New Zealand. I have been personally interested more especially in your rare Pteridophytes, isolated survivals as they surely are of very ancient vegetation. I propose to indicate later in this address some points of interest which they present. But first I shall offer some more general remarks on the history of the investigation of the Australian flora, as a reminder of the recent death of Sir Joseph Hooker, whose work helped so greatly to promote a philosophical knowledge of the flora of this quarter of the globe.

Few, if any, of the large areas of the earth's surface have developed their coat of vegetation under such interesting conditions as that which bears the Australasian flora. In its comparative isolation, and in its freedom from the disturbing influence of man, it may be held as unique. We may picture to ourselves the field as having been open to evolutionary tendencies, unusually free from the incursion of competitive foreign types, and with its flora shaped and determined through long ages in the main by climatic influences. Naturally the controlling effect of animal life had been present throughout, as well as that of parasitic and fungal attack; but that potent artificial influence, the hand of man, was less effective here than in almost any other area. The aborigines were not tillers of the soil: in their digging for roots and such-like actions they might rank with the herbivorous animals, so far as they affected the vegetation. Probably the most powerful influence they exercised was through fire. And so the conditions remained, the native flora being practically untouched, until the visit of Captain Cook in 1770: for little account need be taken of the handful of specimens collected by Dampier in the seventeenth century.

Captain Cook shipped with him in the *Endeavour* a very remarkable man, viz., Joseph Banks, whom Dr. Maiden has described as "the Father of Australia." He not only acted as the scientific director of the expedition, but he was also its financier. Educated at Eton and Oxford, he found himself as a young man possessed of an ample fortune. Though devoted to field sports, he did not, like so many others, spend his life upon them. Following the dictates of a taste early awakened in him, he turned his attention to travel for scientific ends. His opportunity came when Cook was fitting out the *Endeavour* for his first voyage to the Southern Seas. Banks asked leave of the Admiralty to join the expedition, which was granted, and he furnished all the scientific stores and a staff of nine persons at his own expense.

The story of that great expedition of 1768 to 1771 is given in "Cook's Voyages," compiled by Dr. Hawkesworth, a book that may be found in every library. Though it is evident throughout that Banks took a leading part in the observational work of the expedition, it has not been generally known how deeply indebted Hawkesworth was to Banks for the scientific content of his story. This became apparent only on the publication of Banks's own Journal 125 years after the completion of the voyage. The circumstances of this have a local interest, so I may be excused for briefly relating them.

Banks's papers, including the MS. Journal, passed with his library and Herbarium on his death to his librarian, Robert Brown. On the death of the latter they remained in the British Museum. But after lying there for a long period they were claimed and removed by a member of Banks's family, and were put up for auction. The Journal was sold for *7l. 2s. 6d.*, and the last that has been heard of it is that it came into the possession of a gentleman in Sydney. Perhaps it may be lying within a short distance of the spot where we are now met. This valuable record, fit to rank with Darwin's "Voyage of the *Beagle*," or Moseley's account of the "Voyage of the *Challenger*," might thus have been wholly lost to the public had it not been for the care of Dawson-Turner, who had the original transcribed by his daughters, helped by his grandson, Joseph Dalton Hooker. The boy was fascinated by it, and doubtless it helped to stimulate to like enterprises that botanist to whom Australia owes so much. The copy thus made remained in the British Museum. Finally, from it in 1896 Sir Joseph Hooker himself edited the Journal, in a slightly abridged form. It is now apparent how very large a share Banks actually took in the observation and recording, and how deeply indebted to him was the compiler of the account of the voyage published more than a century earlier, not only for facts, but even for lengthy excerpts.

The plants collected in Australia by this expedition amounted to some 1000 species, and with Banks's Herbarium they found, after his death, a home in the British Museum. Several minor collections were subsequently made in Australia, but the next expedition of prime importance was that of Flinders in 1801 to 1805. What made it botanically notable was the presence of Robert Brown. Hooker speaks of this voyage as being, "as far as botany is concerned, the most important in its results ever taken." The collections came from areas so widely apart as King George's Sound, Southern Tasmania, and the Gulf of Carpentaria. These together with Banks's plants and other minor collections, formed the foundation for Brown's "Prodromus Floræ Novæ Hollandiæ," a work which was described in 1860 by Sir Joseph Hooker as being "though a fragment . . . the greatest botanical work that has ever appeared." It was published in 1810. I must pass over without detailed remark the notable pioneer work of Allan Cunningham, and of some others. The next outstanding fact in the history of Australian botany was the voyage of Ross, with the *Erebus* and the *Terror*; for with him was Joseph Hooker, whose botanical work gave an added distinction to an otherwise remarkable expedition.

The prime object of the voyage was a magnetic survey, and this determined its course. But in the intervals of sailing the Antarctic Seas the two ships visited Ascension Island, St. Helena, the Cape, New Zealand, Australia, Tasmania, Kerguelen Island, Tierra del Fuego, and the Falkland Islands. Thus Hooker had the opportunity of collecting and observing upon all the great circumpolar areas of the Southern Hemisphere. He welded together the results results into his great work "The Antarctic Flora." It was published in six large quarto volumes. In them about 3000 species are described, while on 530 plates 1095 species are depicted, usually with detailed analytical drawings. But these magnificent volumes did not merely contain reports of explorations, or descriptions of the many new species collected. There was much more than this in them. All the known facts that could be gathered were incorporated, so that they became systematically elaborated and complete floras of the several countries. Moreover, in the last of them, the "Flora Tasmaniæ," there is an introductory essay, in which the Australasian flora was for the first time treated as a whole, and its probable origin and its relation to other floras discussed. Further, questions of the mutability and origin of species were also raised in it. The air was full of such questions in 1859; the essay was completed in November of that year, less than twelve months after the joint communications of Darwin and Wallace had been made to the Linnean Society, and before the "Origin of Species" was published. It was to this essay that Darwin referred when he wrote that "Hooker has come round, and will publish his belief soon." But this publication of his belief in the mutability of species was not merely an echo of assent to Darwin's own opinion. It was a reasoned statement advanced upon the basis of his own "self-thought," and his own wide systematic and geographical experience From these sources he drew support for "the hypothesis that species are derivative and mutable." He points out how the natural history of Australia seemed specially suited to test such a theory, on account of the comparative uniformity of the physical features being accompanied by a great variety in its flora, and the peculiarity of both its fauna and flora, as compared with other countries. After the test had been made on the basis of the study of some 8000 species of plants, their characters, their spread, and their relations to those of other lands, Hooker concluded decisively in favour of mutability, and a doctrine of progression. After reading this essay, Darwin wrote that it was to his judgment "by far the grandest and most interesting essay on subjects of the nature discussed I have ever read."

But beyond its historical interest in relation to the "Origin of Species," Hooker's essay contained what was up to its time the most scientific treatment of a large area from the point of view of the plant-geographer. He found that the Antarctic, like the Arctic flora, is very uniform round the globe. The same species in many cases occur on every island, though thousands of miles of ocean may intervene. Many of these species reappear in the mountains of Southern Chili, Australia, Tasmania, and New Zealand. The southern temperate floras, on the other hand, of South America, South Africa, Australia, and New Zealand differ more among themselves than do the floras of Europe, Northern Asia, and North America. To explain these facts Hooker suggested the probable former existence, during a warmer period than the present, of a centre of creation of new species in the Southern Ocean, in the form of either a continent or archipelago, from which the Antarctic flora radiated. From the zoological side a similar difficulty arises, and the hypothesis of a land-connection has been widely upheld, and that it existed as late as Mid-Tertiary times. The theory took a more definite form in the hands of Osborn (1900), who pictured relatively narrow strips of land connecting respectively South America on one side and Tasmania and New Zealand on the other with the existing Antarctic land area. This would accord well enough with the suggestion of Lothian Green, that the plan of land-elevations on the earth is approximately tetrahedral; and it is, I believe, in line with the views of those who are best informed on Antarctic geography and geology, as studied from the land itself. It may be hoped that further Antarctic discovery may bring fresh facts to bear upon this question, for it is to the positive data acquired from study of the earth's crust that we must look, rather than to the exigencies of botanists and zoologists, for its final solution.

But the hypothesis of an Antarctic land-connection has been held open to doubt in various quarters. As Sir Wm. Thistleton-Dyer has recently pointed out, Darwin himself dissented, though regretfully, from the sinking of imaginary continents in a quite reckless manner, and from the construction of land-bridges in every convenient direction. From the geological side Dana laid down the positive proposition that the continents and oceans had their general outline and form defined in earliest time. Sir John Murray, whose recent death we so deeply deplore, was an undeniable authority as to the ocean-floor. He wrote quite recently with regard to Gondwana-land, that "the study of ocean-depths and ocean-deposits does not seem in any way to support the view that continental land has disappeared beneath the floor of the ocean in the manner indicated." He suggested that the present distribution of organisms is better interpreted by the North Polar theory of origin. The "continuous current of vegetation" southward at the present time was recognised by Hooker himself, and definite streams of northern forms have been traced by him extending even to Australia and Tasmania. This might account for much in present-day distribution; though it seems doubtful whether it would fully explain the extraordinary distribution of Antarctic plants. The problem must for the present remain open.

This whole question, however, has a connection with the still wider difficulty of the existence within the Polar area of ancient floras. In the north the fossils are even of subtropical character. Coal has been found in lands with a five months' night. How did such plants fare if the seasonal conditions were at all like the present? To explain this it would be a physiological necessity to assume either an entirely different climatal condition in those regions from that of the present time; or, as has been suggested, some shifting or creeping of the earth's crust itself. These are, however, questions which we cannot undertake to discuss with effect in the Botanical Section. We must not do more than recognise that an unsolved difficulty exists.

We pass now from Hooker's great work to the last of the classical series, viz. the "Flora Australiensis" of Bentham and Baron Ferdinand von Müller. It is embodied in seven volumes, and was completed in 1878. Bentham, while assenting in his "concluding preface" to the principles laid down by Hooker in the Tasmanian flora, recognised as the chief component part of the present flora of Australia the indigenous genera and species, originated or differentiated in Australia, which never spread far out of it. Secondly, an Indo-Australian flora showing an ancient connection between Australia and the lands lying to the north. It is represented especially in tropical and subtropical East Queensland. Then there is the mountain flora common to New Zealand, and extending generally to the southern extra-tropical and mountain regions, while other constituents are ubiquitous maritime plants, and those which have been introduced since the European colonisation. But the most remarkable, as they are the least easily explained, are some few plants identical with species from North and West America, and from the Mediterranean. They are stated to be chiefly annuals, or herbaceous or shrubby plants; free-seeders; while their seeds long retain the power of germination. This may perhaps give the clue to this curious conundrum of distribution.

It has been fortunate that the duty of working out this remarkable flora should have fallen into the hands of such masters as Robert Brown, Sir Joseph Hooker, and Bentham. The foundations were thus surely laid. The further progress of knowledge has been carried on by the late Baron Ferdinand von Müller, and it may be confidently left in the hands of others who are still with us. The completion of the task of observing and recording may still be far ahead. But I may be pardoned if I utter a word of anticipatory warning. There is at the present time a risk that the mere work of tabulating and defining the species in a given country may be regarded as the only duty of a Government botanist; that, whenever this is completed, his occupation will be gone. Some such erroneous idea, together with a short-sighted economy, is the probable explanation of the fact that certain positions hitherto held by professional botanists have recently been converted into positions to be held by agriculturists. In the countries where this has happened (and I refer to no part of Australasia) the vegetation had been very adequately, though not yet exhaustively, worked, as regards the flowering plants and ferns. But who that knows anything about plants would imagine that the ascription to a genus or order, or the designation by a couple of Latin names with a brief specific description, exhausts what it is important to know about a species? In most cases it is after this has been done that the real importance of its study begins. Such possibilities as these do not appear to have been appreciated by those who advised or controlled these official changes. I have no desire to undervalue the agriculturist or the important work which he does. But he is engaged in the special application of various pure sciences, rather than in pure science itself. Advance in the prosperity of any country which has progressed beyond the initial stages of settlement follows on the advance of such knowledge as the devotee of pure science not only creates, but is also able to inculcate in his pupils. It is then imperative that, in any State which actively progresses, provision shall be made for the pursuit of pure as well as of applied science. In my view an essential mistake has been made in changing the character of the appointments in question from that of botanists to that of agriculturists. For the change marks the abandonment of pure science in favour of its specialised and local application.

The head of such an institution should always be a representative of pure science, thoroughly versed in the nascent developments of his subject. He could then delegate to specialists the work of following out in detail such various lines of special application as agriculture, acclimatisation, plant-breeding, forestry, or economics. Or, if the organisation were a large one, as we may anticipate that it would become in the capital of a great State, separate institutes might develop to serve the several applied branches, while to a central institute, in touch with them all, might be reserved the duty of advancing the pure science from which all should draw assistance and inspiration.

It matters little how this principle works out in detail, if only the principle itself be accepted, viz., that pure science is the fount from which the practical applications spring. Sydney, as the capital of a great State, has already laid her course, as regards botanical science, in accordance with it. Her Botanic Garden and the recently developed Botanical Department in the University (which, I understand, may find its home ultimately in the Botanic Garden) will serve as centres of study of the pure science of botany. This will readily find its application to agriculture, to forestry, to economics, and in various other lines present and future. I am convinced that it is in the best interest of any State that can possibly afford to do so to encourage and endow liberally the central establishment where the pure science of botany is pursued, and to continue that encouragement and endowment, even though results of immediate practical use do not appear to be flowing from it at any given moment. For in these matters it is impossible to forecast what will and what will not be eventually of practical use. And in any case as educational centres the purely botanical establishments will always retain their important function of supplying that exact instruction, without which none can pursue with full effect a calling in the applied branches.

We may now turn from generalities to certain points of interests in your peculiar flora which happen to have engaged my personal attention. They centre round a few rare and isolated plants belonging to the Pteridophyta, a division of the vegetable kingdom which there is every reason to believe to have appeared relatively early in the history of evolution. But though the type may be an ancient one, it does not follow that every representative of it preserves the pristine features intact. Throughout the ages members of these early families may themselves have progressed. And so among them to-day we may expect to find some which preserve the ancient characters more fully than others. The former have stood still, and may be found to compare with curious exactitude with fossils even of very early date. The latter have advanced, and though still belonging to the ancient family, are by their modifications become essentially modern representatives of it. For instance, the fern Angiopteris has a sorus which very exactly matches sori from the Palæozoic period, and it may accordingly be held to be a very ancient type of fern. On the other hand, the genera Asplenium, or Polypodium, include ferns of a type which has not been recognised from early fossil-bearing rocks, and they may be held to be essentially modern. But still all of them clearly belong to the family of the Ferns.

In the Australian flora only three of the four divisions of the Pteridophyta are represented. For, curiously enough, there does not appear to be any species on your continent of the widely spread genus Equisetum, the only living genus of that great phylum of the Equisetales, which figured so largely in the Palæozoic period; and this notwithstanding that one species (*E. debile*) is present among the Polynesian Islands. But all the three other divisions of the Pteridophyta are included, and are represented in each case by plants which show peculiar and probably for the most part archaic characters. I propose to sketch before you very briefly the points of interest which the more notable of these archaic types present. Some justification may be found for my doing so because nearly all of them have been submitted to detailed study in my laboratory in Glasgow, and much of the work has been done upon material supplied to me by your own botanists. I take this opportunity of offering to them collectively my hearty thanks.

The tenure by Dr. Treub of the office of director of the Botanic Gardens of Buitenzorg, was rendered famous by his personal investigations, and chiefly by his classical researches on the Lycopods. These were followed up by other workers, and notably by Bruchmann; so that we now possess a reasonable basis for comparison of the different types of the family as regards the prothallus and embryology, as well as of the sporophyte plant; and all these characters must be brought together as a basis for a sound conclusion as to their phyletic seriation. The most peculiar living Lycopods are certainly Isoëtes and Phylloglossum, both of which are found in Australia. The former need not be specially discussed here, as it is a practically world-wide genus. It must suffice to say that it is probably the nearest living thing to the fossils Lepidodendron and Sigillaria, and may be described as consisting of an abbreviated and partially differentiated Lepidostrobus seated upon a contracted stigmarian base.

But Phylloglossum, which is peculiar to the Australasian region, naturally claims special attention. The plant is well known to botanists as regards its external features, its annual storage tuber, its leafy shoot with protophylls and roots, and its simple shaft bearing the short strobilus of characteristic Lycopod type. But its prothallus has never been properly delineated, though it was verbally described by Dr. A. P. W. Thomas in 1901 (Proc. Roy. Soc., vol. lxix., p. 285). Perhaps the completed statement may have been reserved as a pleasant surprise for this meeting. But the description of thirteen years ago clearly shows its similarity to the type of *Lycopodium cernuum*. The sporophyte compares rather with *L. inundatum*. Both of these are species which, though probably not the most primitive of the genus, are far from being the most advanced. As all botanists know, the question of the position of Phylloglossum chiefly turns upon the view we take of the annual tuber and its protophylls. Treub, finding similar conditions in certain embryos of Lycopods, called it a "protocorm," and believed that he recognised in it an organ of archaic nature, which had played an important part in the early establishment of the sporophyte in the soil, physiologically independent of the prothallus. I must not trouble you here with the whole argument in regard to this view. Facts which profoundly affect the conclusion are those showing the inconstancy of occurrence of the organ. Mr. Holloway has recently described it as of unusual size in your native *L. laterale*, as it is also in *L. cernuum*. But it is virtually absent in those species which have a large intraprothallial foot, such as *L. clavatum*, as well as in the genus Selaginella and in Isoëtes. In *L. selago*, which on other grounds appears to be primitive, there is no "protocorm." Such facts appear to me to indicate caution. They suggest that the "protocorm" is an opportunist local swelling of inconstant occurrence, which, though biologically important in some cases, is not really primitive.

If this is the comparative conclusion, then our view will be that Phylloglossum is a type of Lycopod which has assumed, perhaps relatively recently, a very practical mode of annual growth. Related, as it appears to be on other points, with the *L. inundatum* group of species, it has bettered their mode of life. *L. inundatum* dies off each year to the very tip of its shoot, so that only the bud remains to the following season. It is notable that Goebel has described long ago how the young adventitious buds of this species start with small "protocorms," quite like those of Phylloglossum itself, or like the embryo of *L. cernuum*. And so we may conclude that in Phylloglossum a tuberous development, containing a store to start the plant in the spring, has been added to what is already seen normally each year in *L. inundatum*. And this mode of life of Phylloglossum begins, as Thomas has shown, with its embryo. This appears to me to be a rational explanation of the "protocorm" of Phylloglossum; but it robs the plant of much of its theoretical interest as an archaic form.

The phylum of the Sphenophyllales was originally based on certain slender straggling plants of the genus Sphenophyllum found in the Palæozoic Rocks; but they apparently died out in the Permian period. Your native genera, Tmesipteris and Psilatum, were ranked by earlier botanists with the Lycopods, but a better acquaintance with their details, and especially the examination of numerous specimens on the spot, indicated a nearer affinity for them with the Sphenophyllales. It was Prof. Thomas who in 1902 first suggested that the Psilotaceæ might be included with the Sphenophyllæ in the phylum of the Sphenophyllales, and I personally agree with him. Dr. Scott, however, dissents, on the ground that the leaves are persistently whorled in the sphenophylls, while they are alternate in the Psilotaceæ; and while the former branch monopodially the latter dichotomise. But since both these characters are seen to be variable within the not far distant genus Lycopodium, the differences do not seem to me to be a sufficient ground for keeping them apart as the separate phyla of Sphenophyllales and Psilotales. Whatever degree of actual relation we trace, such plants as Tmesipteris and Psilotum are certainly the nearest living representatives of the Sphenophylleæ, a fact which gives them a special distinction. The Psilotaceæ also stand alone in the fact that they are the only family of the Pteridophytes in which the gametophyte is still unknown. They produce spores freely, but there the story stops. Any young Australian who hits upon the way to induce these recalcitrant spores to germinate, and to produce prothalli and embryos, or who found their prothalli and embryos in the open, would have before him a piece of work as sensational as anything that could be suggested. Further, I am told that Tmesipteris grows here on the matted stumps of *Todea barbara*. I shall be alluding shortly to the fossil Osmundaceæ. May we not venture to fancy the possibility of some fossil Osmunda being found which has embalmed for us among its roots a Mesozoic or even a Tertiary Sphenophyll? And thus a link might be found between the Palæozoic types and the modern Psilotaceæ, not only in time, but even in character.

We pass now to the last phylum of the Pteridophyta, the Filicales. I am bound to say that for me its interest far outweighs that of the others, and for this reason: that it is represented by far the largest number of genera and species at the present day, while there is a sufficiently continuous and rich succession of fossil forms to serve as an efficient check upon our comparative conclusions.

Since 1890 it has been generally accepted that the Eusporangiate ferns (those with more bulky sporangia) were phyletically the more primitive types, and the Leptosporangiate (those with more delicate sporangia) the derivative, and in point of time later. The fossil evidence clearly upholds this conclusion. But, further, it has been shown that the character of the sporangium is merely an indicator of the general constitution of the plants in question. Where it is large and complex, as in the Eusporangiates, all the apical segmentations are, as a rule, complex, and the construction of the whole plant relatively bulky. Where the sporangium is delicate and relatively simple all the apical segmentations follow suit, and the construction of the plant is on a less bulky model. On this basis we may range the ferns roughly as a sequence, starting from relatively bulky types of the distant past, and progressing to the more delicate types of the present day. The large majority of the living species belong naturally to the latter. But the former are still represented by a few genera and species which, like other survivals from a distant past, are frequently of very restricted distribution.

An interesting feature of the Australasian flora is that a considerable number of these relatively ancient forms are included in it. Thus the Marattiaceæ are represented by one species of Marattia and one of Angiopteris. Though in themselves interesting, they will be passed over without special remark, as they are very widely spread tropical forms.

All the three genera of Ophioglossaceæ are included, there being two species of Ophioglossum and two of Botrychium, while Helminthostachys is recorded from Rockingham Bay. This family is coming more than ever to the front in our comparisons, owing to their similarity in various aspects to the ancient Botryopterideæ. Though the Ophioglossaceæ have no secure or consecutive fossil history, still they may now be accepted as being very primitive but curiously specialised ferns. Perhaps the most interesting point recently detected in them is the suspensor found by Dr. Lyon in *Botrychium obliquum*, and by Dr. Lang in Helminthostachys. This provides a point for their comparison with the similar embryonic condition in Danœa, as demonstrated by Prof. Campbell. The existence of a filamentous initial stage of the embryo is thus shown for three of the most primitive of living ferns. Its existence in all of the Bryophytes, and in most of the Lycopods, as well as in the seed-plants, is a very significant fact. Dr. Lang suggests that "the suspensor represents the last trace of the filamentous juvenile stage in the development of the plant, and may have persisted in the seed-plants from their filicineous ancestry." Such a possibility would fit singularly well with the theory of encapsulation of the sporophyte in the venter of the archegonium.

The representation of the ancient family of the Osmundaceæ in the Australasian flora is very fine, though limited to five living species, while Osmunda itself is absent. It is, however, interesting that the family dates back locally to early fossil times. It was upon two specimens of Osmundites from the Jurassic Rocks in the Otago district of New Zealand that the series of remarkable papers on the fossil Osmundaceæ by Kidston and Gwynne-Vaughan was initiated. It is no exaggeration to say that these papers have done more than any other recent researches to promote a true understanding, not only of the Osmundaceæ themselves, but of fern-anatomy as a whole. They have placed the stellar theory in ferns for the first time upon a basis of comparison, checked by reference to stratigraphical sequence. It would be leading us too far for me to attempt here to summarise the important results which have sprung from the study of those fossils, so generously placed by Mr. Dunlop in the hands of those exceptionally able to turn them to account. It must suffice to say that it is now possible to trace as a fairly continuous story the steps leading from the protostelic state to the complex condition of the modern Osmunda. These facts and conclusions are to be put in relation with the anatomical data fast accumulating from the Ophioglossaceæ in the hands of Prof. Lang and others. From such comparisons a rational explanation of the evolutionary steps leading to the complex stelar state in ferns at large begins to emerge. This is no mere tissue of surmises, for the conclusions are based on detailed comparison of types occurring in lower horizons with those of the present day.

I must pass over with merely nominal mention your interesting representation of the ancient families of Schizæaceæ, Gleicheniaceæ, and Hymenophyllaceæ, all of which touch the very foundations of any phyletic system of ferns. Also the magnificent array of Dicksonieæ and Cyatheæ, and of the important genus Lindsaya—ferns which take a rather higher position in point of view of descent. But I am bound to devote a few moments to one of your most remarkable ferns, endemic in New Zealand—the monotypic Loxsoma.

This species has peculiar characters which justify its being regarded systematically as the sole representative of a distinct tribe. It is also restricted geographically to the North Island of New Zealand. These facts at once suggest that it is an ancient survival, a conclusion with which its solenostelic axis, its sorus and sporangium, and its prothallus readily accord. I have lately shown that the Leptosporangiate ferns fall into two distinct series, those in which the origin of the sorus is constantly superficial, and those in which it is as constantly marginal. Loxsoma is one of the "Marginales." It shares this position with the Schizæaceæ, Thyrsopterideæ, Hymenophyllaceæ, and Dicksonieæ, and the derivatives Davallieæ and Oleandreæ. Its nearest living relative is probably Thyrsopteris, which is again a monotypic species endemic in the island of Juan Fernandez. There is also a probable relation to the genus Loxsomopsis, represented by one species from Costa Rica, and a second lately discovered in Bolivia. Such a wide and isolated distribution of types, which by their characters are certainly archaic, suggests that we see in them the relics of a filicineous state once widely spread, which probably sprang from a Schizæaceous source, and with them represent the forerunners of the whole marginal series. If we look for further enlightenment from the fossils, it is to the Secondary rocks that we should turn. It is then specially interesting that Mr. Hamshaw Thomas has lately described a new Jurassic fern, *Stachypteris halli*, which has marginal sori, and is probably referable to a position like that of Loxsoma and Thyrsopteris, between the Schizæaceæ and the Dicksonieæ. In fact, the gaps in the evolutionary series of the Marginales are filling up. We may await with confidence fresh evidence from the Jurassic period, upon which Prof. Seward is directing an intensive interest.

I should be ungrateful indeed if I did not mention your very full representation of Blechnoid ferns: for developmental material of several of these has been sent to me by Dr. Cockayne, and others from New Zealand. A wide comparative study of the genus has led me to somewhat unexpected results in regard to the plasticity of the sorus, its phyletic fusions and disruptions. The consequent derivative forms are seen in Woodwardia and Doodya on one hand, and on the other in Scolopendrium and Asplenum. These ferns together constitute a coherent phylum springing ultimately from a Cyatheoid source. The details upon which this conclusion is based I hope to describe in a separate communication to the section.

And, lastly, the Hydropterideæ deserve brief mention. Represented in your flora by two species of Azolla, and one each of Marsilea and Pilularia, they typify a condition which must theoretically have existed among ferns in very early times, viz., the heterosporous state. But hitherto, notwithstanding the existence of our living Hydropterideæ, no fossil fern with microscopic structure preserved had been detected from the primary rocks, showing this intermediate condition between the homosporous type and that of the pteridosperms. This unsatisfactory position has now been resolved by Professor Lignier, who has recently described, under the name of Mittagia, a fossil from the Lower Westphalian, which bore sori of which the sporangia contained four megaspores, while the outer tissues of the sporangia resembled those of Lagenostoma. Pending the discovery of further specimens, these observations may be welcomed as filling with all probability a conspicuous gap in the evolutionary sequence of known forms.

From the rapid survey which I have been able to give you of some of the more notable Australasian ferns of relatively archaic type, it is clear that they have a very interesting and direct bearing upon the phylesis of ferns. The basis upon which conclusions as to phyletic sequence are arrived at is at root that of the natural system of classification generally—the recognition, not of one character, or of two, but of as many as possible, which shall collectively serve as criteria of comparison. In the case of the Filicales we may use the characters of:—

(i) External form.
(ii) Constitution, as shown by simple or complex segmentation.
(iii) Dermal appendages, hairs or scales.
(iv) Stelar structure, simple or complex.
(v) Leaf-trace, coherent or divided.
(vi) Soral position.
(vii) Soral construction.
(viii) Indusial protections.
(ix) Sporangial structure, and mechanism of dehiscence.
(x) Spore-output.
(xi) Spore-form, and character of wall.
(xii) Form of prothallus.
(xiii) Position of the sexual organs, sunken or superficial.
(xiv) Number of spermatocytes, and method of dehiscence.
(xv) Embryology.

In respect of all these criteria progressions of character may be traced as illustrated by known ferns, and probably other criteria may emerge as study progresses. In each case, upon a footing of general comparison, checked as opportunity offers by reference to the stratigraphical sequence of the fossils, it may be possible to distinguish with some degree of certainty what is relatively primitive from what is relatively advanced. Thus, the protostele is generally admitted to be more primitive than the dictyostele, the simple hair than the flattened scale, and a high spore-output than a low one.

Applying the conclusions thus arrived at in respect of the several criteria, it becomes possible upon the sum of them to lay out the species and genera of ferns themselves in series, from the primitive to the advanced. In proportion as the progressions on the basis of the several criteria run parallel, we derive increased assurance of the rectitude of the phyletic sequences thus traced, which may finally be clinched, as opportunity offers, by reference to the stratigraphical occurrence of the corresponding fossils. This is in brief the phyletic method, as it may be applied to ferns. It may with suitable variation be applied to any large group of organisms, though it is seldom that the opportunities for such observation and argument are in any sense commensurate with the requirements. Perhaps there is no group of plants in which the opportunities are at the moment so great as in the Filicales, and they are yielding highly probable results from its application.

The greatest obstacle to success is found in the prevalence of parallel development in phyla which are believed to have been of distinct origin. This is exemplified very freely in the ferns, and the systematist has frequently been taken in by the resemblances which result from it. He has grouped the plants which show certain common characters together as members of a single genus. Sir William Hooker in doing this merged many genera of earlier writers. His avowed object was not so much to secure natural affinity in his system as readiness of identification: and consequently in the "Synopsis Filicum" there are nominal genera which are not genera in the phyletic sense at all. For instance, Polypodium and Acrostichum, as there defined, may be held from a phyletic point of view to be collective groupings of all such ferns as have attained a certain state of development of their sorus; and that they are not true genera in the sense of being associated by any kinship of descent: this is shown by the collective characters of the plants as a whole. Already at least four different phyletic sources of the Acrostichoid condition have been recognised, and probably the sources of the Polypodioid condition are no fewer. Such "genera" represent the results of a phyletic drift, which may have affected similarly a plurality of lines of descent. It will be the province of the systematist who aims at a true grouping according to descent to comb out these aggregations of species into their true relationships. This is to be done by the use of wider, and it may be quite new, criteria of comparison. Advances are being made in this direction, but we are only as yet at the beginning of the construction of a true phyletic grouping of the Filicales. The more primitive lines are becoming clearer: but the difficulty will be greatest with the distal branches of the tree. For these represent essentially the modern forms, they comprise the largest number of apparently similar species, and in them parallel development has been most prevalent.

If this difficulty be found in such a group as the Filicales, in which the earlier steps are so clearly indicated by the related fossils, what are we to say for the Angiosperms? Our knowledge of their fossil progenitors is very fragmentary. But they are represented now by a multitude of forms, showing in most of their features an irritating sameness. For instance, vascular anatomy, that great resource of phyletic study in the more primitive types, has sunk in the Angiosperms to something like a dead level of uniformity. There is little variety found in the contents of embryo-sacs, in the details of fertilisation, or in embryology. Even the ontogeny as shown in the seedling stages affords little consolation to the seeker after recapitulation. On the other hand, within what are clearly natural circles of affinity there is evidence of an extraordinary readiness of adaptability in form and structure. Such conditions suggest that we see on one hand the far-reaching results of parallel development, and on the other the effects of great plasticity at the present day, or in relatively recent times. Both of these are points which prevent the ready tracing of phyletic lines. In the absence of trustworthy suggestions from palæontology, the natural consequence is the current state of uncertainty as to the phyletic relations of the Angiosperms.

Various attempts have been or are being made to meet the difficulty. Some, on the basis of the recent observations of Wieland and others, are attempting along more or less definite monophyletic lines to construct, rather by forcible deduction than by any scientific method of induction, an evolutionary story of the Angiosperms. I do not anticipate that any great measure of success, beyond what is shown in a very polysyllabic terminology, and an appearance of knowing more than the facts can quite justify, will attend such efforts. It would seem to me to be more in accord with the dictates of true science to proceed in a different way, as indeed many workers have already been doing. To start, not from preconceptions based upon limited palæontological data, but from an intensive study of the living plants themselves. To widen so far as possible the criteria of comparison, by making, for instance, every possible use of cellular, physiologico-chemical, and especially secretory detail, and of minor formal features, such as the dermal appendages, or by initiating a new developmental morphology of the flower from the point of view of its function as a whole: and with its physiological end clearly in sight, viz. the maturing, nourishing, and placing of new germs. To make on some such basis intra-ordinal, and intra-generic comparisons with a view to the phyletic seriation of closely related forms; and so to construct probable short series, which may subsequently be associated into larger phyletic groupings. This should be checked wherever possible by physiological probability. A keen eye should be kept upon such information as geographical distribution and palæontology may afford, and especially upon the fossils of the Mesozoic period. What is above all needed for success among the Angiosperms is new criteria of comparison, to meet the far-reaching difficulties that follow from parallel development and recent adaptation. If some such methods be adopted, and strenuously pressed forward, the task should not appear hopeless, though it cannot be anything else than an arduous one.

I cannot conclude without some remark on the bearing of parallel or convergent development, so fully exemplified in the Filicales, upon the question of the genesis of new forms. Anyone who examines, from the point of view suggested in this address, the larger and well-represented divisions of the Vegetable Kingdom must be impressed with the extraordinary dead level of type to which their representatives have attained. In most of these divisions the phyletic history is obscured, partly by the absence of any consecutive palæontological record, but chiefly by the want of recognised criteria for their comparison. This is very prominently the case for the Mosses, and the Angiosperms.

But it may be doubted whether these large groups differ in any essential point, in respect of the genesis of their multitudinous similar forms, from the Filicales, in which the lines of descent are becoming clearer through additional knowledge. Suppose that we knew of no fossil Ferns; and that none of the early fern-types included under the term "Simplices" had survived in our living flora: and that the Filicales of our study consisted only of the 2500 living species of the old undivided genera of Polypodium, Asplenium, Aspidium, and Acrostichum. Then the phyletic problem of the Filicales would appear as obscure as does that of the Mosses, or of the Angiosperms of the present day. They would present, as these great groups now do, an apparent dead level of sameness in type, though the phyletic starting-points in each may have been several and distinct. There is every reason to suppose that in the phylesis of the Mosses or the Angiosperms also there has been a parallel, and even a convergent, development of the same nature as that which can be cogently traced in the Filicales: but that it is obscured by the obliteration of the early stages. Internal evidence from their comparative study fully justifies this conclusion. How, then, are we to regard this insistent problem of parallelism and convergence from the point of view of genetic study?

A belief in the "inheritance of acquired characters," or, as is sometimes expressed, "somatic inheritance," is at present out of fashion in some quarters. But though powerful voices may seem to have forced it for the moment into the background, I would take leave to point out that such inheritance has not been disproved. All that has been done, so far as I understand the position, is to show that the evidence hitherto advanced in support of it is insufficient for a positive demonstration. That is a very different thing from proving the negative. We hear of "fluctuating variations" as distinct from "mutations"; and it is asserted that the former are somatic, and are not inherited, while the latter are inherited. This may be held as a useful terminological distinction, in so far as it accentuates a difference in the heritable quality. But it leaves the question of the origin of these heritable "mutations" quite open. At the present moment I believe that actual knowledge on this point is very like a complete blank. Further, it leaves indefinite the relative extent and proportion of the "mutations." It is commonly held that mutations are considerable deviations from type I am not aware that there is any sufficient ground for such a view. It may probably have originated from the fact that the largest are most readily observed and recognised as reappearing in the offspring. But this is no justification for ignoring the possibility of all grades of size or importance of heritable deviations from type.

On the other hand, adaptation, with its consequence of parallel or even convergent development in distinct stocks, is an insistent problem. The real question is: What causes are at work to produce such results? They are usually set down to the selection of favourable divergences from type out of those produced at random. But the prevalence of parallelism and convergence suggests that those inheritable variations, which are now styled "mutations," are not produced at random. These facts enforce the question whether or not they are promoted and actually determined in their direction, or their number, or their quality, in some way, by the external conditions. Parallelism and convergence in phyletic lines which are certainly distinct impress the probability that they are. Until the contrary is proved it would, in my opinion, be wiser to entertain some such view as a working hypothesis than positively to deny it. Such a working hypothesis as this is not exactly the same as a "mnemic theory," though it is closely akin to it. It may perhaps be regarded as the morphologist's presentation, while the mnemic theory is rather that of the physiologist. But the underlying idea is the same, viz. that the impress of external circumstance cannot properly be ruled out in the genesis of inheritable characters, simply because up to the present date no definite case of inheritance of observable characters acquired in the individual lifetime has been demonstrated. Of course, I am aware that to many this is flat heresy. At this meeting of the Association it amounts almost to high treason. I plead guilty to this heresy, which may by any sudden turn of observation be transformed into the true faith. I share it in whole or in part with many botanists, with men who have lived their lives in the atmosphere of experiment and observation found in large botanic gardens, and not least with a former President of the British Association, viz. Sir Francis Darwin.

It is noteworthy how large a number of botanists dissent from any absolute negation of the influence of the environment upon the genesis of heritable characters. Partly this may be due to a sense of the want of cogency of the argument that the insufficiency of the positive evidence hitherto adduced justifies the full negative statement. But I think it finds its real origin in the fact that in plants the generative cells are not segregated early from the somatic. In this respect they differ widely from that early segregation of germ-cells in the animal body, to which Weismann attached so much importance. The fact is that the constitution of the higher plants and of the higher animals is in this, as in many other points, radically different, and arguments from one to the other are dangerous in the extreme. Those who interest themselves in evolutionary questions do not, I think, sufficiently realise that the utmost that can be claimed is analogy between the higher terms of the two kingdoms. Their phyletic separation certainly dates from a period prior to that of which we have any knowledge from the fossil record. Let us give full weight to this fact, as important as it is indisputable. The early definition of germ-cells in the animal body will then count for nothing in the evolutionary problem of plants. Moreover, we shall realise that the plant, with its late segregation of germ-cells, will present the better field for the inquiry whether, and how far, the environment may influence or induce divergences from type. From this point of view the widespread opinion among botanists that the environment in some sense determines the origin and nature of divergences from type in plants should command a special interest and attention.

I must now draw to a close. I have passed in review some of your more notable plants, and pointed out how the Australasian flora, whether living or fossil, includes in unusual richness those evidences upon which the fabric of evolutionary history is being based. I have indicated how this history in certain groups is showing ever more and more evidence of parallel development, and that such development, or convergence, presses upon us the inquiry into the methods of evolutionary progress. The illustrations I have brought forward in this address clearly show how important is the positive knowledge derived from the fossils in checking or confirming our decisions. Palæophytology is to be prized not as a separate science, as, with an enthusiastic view restricted between blinkers, a recent writer has endeavoured to enforce. To treat it so would be to degrade it into a mere side alley of study, instead of holding it to be the most positive line that we possess in the broad avenue of botanical phylesis. An appreciation of such direct historical evidence is no new idea. Something of the same sort was felt by Shakespeare three centuries ago, and it remains the same to-day. Nay, more: it may lead us even to forecast future possibilities. In following our evolutionary quest in this spirit we shall find that we are indeed—

> "Figuring the nature of the times deceased
> The which observed, a man may prophesy
> With a near aim, of the main chance of things
> As yet not come to life."
>
> (King Henry IV., Part II, Act iii., Scene i.)

THE WIDMANSTATTEN STRUCTURE IN VARIOUS ALLOYS AND METALS.[1]

THE surface of meteoric iron after polishing and etching in the way usually adopted, prior to examination under the microscope, shows characteristic figures which are for the most part triangles or parallelograms. These figures were observed for the first time in 1808 by M. Alois de Widmanstätten, the director of the Imperial Porcelain Works at Vienna on the Ilraschina meteorite, and although Widmanstätten himself had published nothing regarding his discoveries, a knowledge of them spread very quickly, and what he had seen were soon universally known under the name of "Widmanstätten figures." It was then generally considered that these figures were characteristic of meteoric iron and that they were not found in terrestrial iron. Guillet-Laumont[2] in 1813 already saw an analogy between the two varieties of iron; but the majority of investigators for a long time were of a different opinion, and the views of Guillet-Laumont were forgotten.

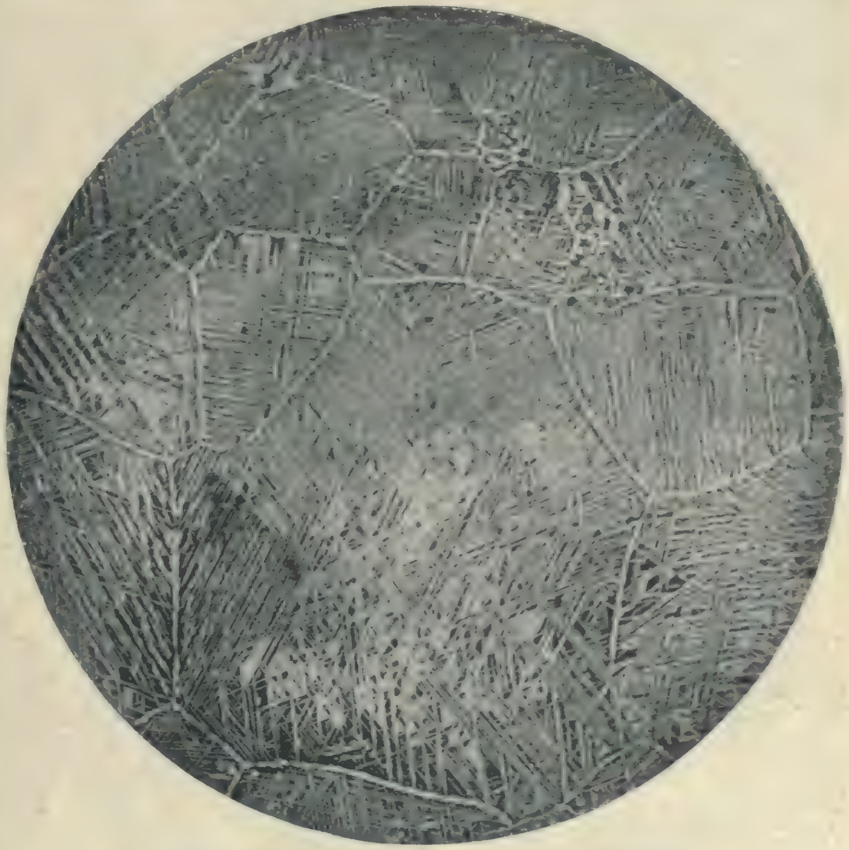

FIG. 1.—Widmanstätten Structure in Carbon Steel (Carbon 0·55 per cent.). Alloy No. 8. Magnified 8 diameters.

The interest in meteorites shown by Dr. Sorby, the founder of the science of metallography, and especially the brilliant researches of Osmond, led anew to attention being directed to the figures of Widmanstätten. Thus it was that in 1900 M. Osmond announced the discovery in the head of a steel ingot of equilateral triangles which recalled, he said, "the figures of Widmanstätten, which are known to belong to the regular octahedral system."[3]

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[1] Paper presented to the Institute of Metals for the September meeting by Capt. N. T. Belaiew (Michael Artillery Academy, Petrograd). Translated from the French of the original MS. of Capt. Belaiew, and, in consequence of the European War, not since revised by him.

[2] Cohen, *Meteoritenkunde*, 1894, vol. i., p. 41.

In a previous paper[4] the author described a steel containing 0·55 per cent. of carbon, prepared in 1908 at the works of Igewsky in accordance with the directions of the author. This steel showed throughout its mass beautiful Widmanstätten figures, which were so developed that they were perfectly visible to the naked eye (Fig. 1). The analogy between the structure of the alloy and that of the meteorites was so close that the author considers that it may be regarded as a synthetic production of a meteoritic structure, and that it is fair to refer to this structure as the Widmanstätten structure (Figs. 2 and 3).

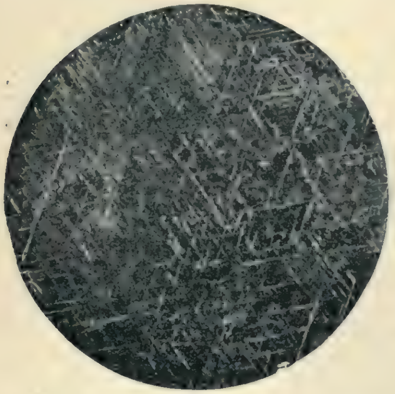

FIG. 2.—Widmanstätten Structure in Taze-well Meteorite. Section parallel to the Surface of the Octahedron. Magnified 6 diameters and slightly reduced.

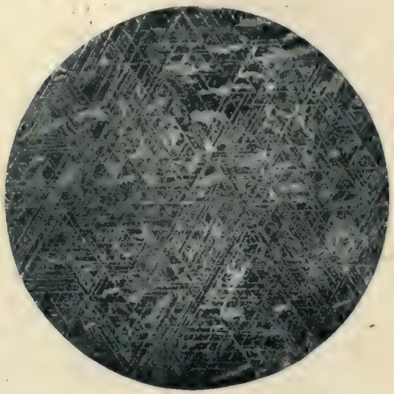

FIG. 3.—Widmanstätten Structure in Carbon Steel (Carbon, 0·55 per cent.). Alloy No. 8. Magnified 9 diameters and slightly reduced.

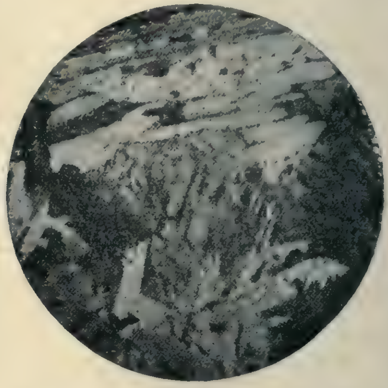

FIG. 4.—Swedish Iron heated to the point of Incipient Fusion (Osmond, "Sur la Cristallographie du Fer"). Magnified 16 diameters.

Not only could the meteoritic structure be henceforth artificially reproduced at will, but the crystallisation of iron as well as its crystallography could be easily studied from such examples.

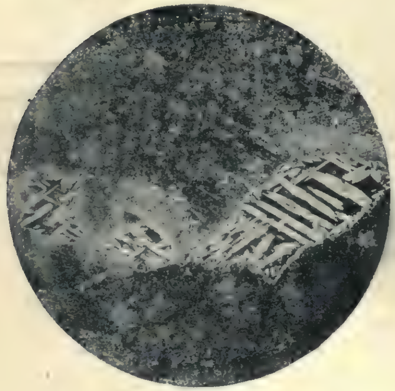

FIG. 5.—Widmanstätten Structure in Bronze, containing 55·1 per cent. Copper. Cooled in Sand and Annealed (L. Guillet, "Les Laitons au Nickel"). Magnified 30 diameters and slightly reduced.

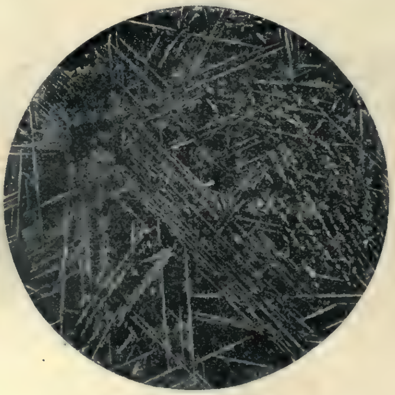

FIG. 6.—Widmanstätten Structure in Alloy of 90 per cent. Platinum and 10 per cent. Aluminium (Chouriguine, "Sur les alliages du Platine avec l'Aluminium"). Magnified 50 diameters and slightly reduced.

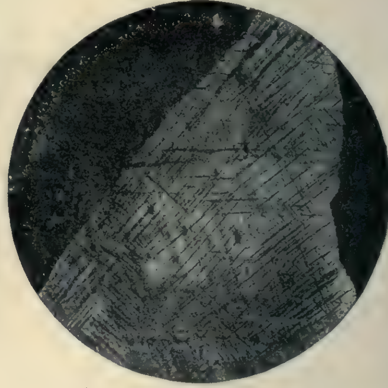

FIG. 7.—Widmanstätten Structure in Zinc, cast and cooled slowly (G. Timothéeff). Magnified (?) diameters and slightly reduced.

Although the question of the conditions which led to the appearance of this structure seemed extremely interesting, nevertheless it was considered wise to leave it on one side for the moment and to commence with what might be termed a more or less detailed "morphological" examination. From this it was not difficult to see that the character of the Widmanstätten figures changed several times in a given area, sometimes showing triangles, sometimes squares, but they are precisely the figures that would be expected in different sections of a regular octahedron the four systems of cleavages of which were parallel to the four pairs of its surfaces, an arrangement known for a long time in the case of meteorites.[5] Thus it was the octahedral crystallisation of iron which was made manifest by the distribution of the structural elements between the cleavage planes during the recrystallisation.[6] The octahedral crystallisation of alloys of iron is generally admitted,[7] and the greater part of the iron-carbon diagram belongs to the type of diagrams in which there is recrystallisation in the solid state.

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[3] "Sur la Cristallographie du Fer," Paris, 1900, p. 24, figs. 24 and 25. The same observation was made in 1905 by Profs. Arnold and McWilliam in their memoir, "The Thermal Transformation of Carbon Steel," Journ. of the Iron and Steel Institute, 1905, No. II., p 35.

[4] "Sur la reproduction artificielle de la structure de Widmanstätten dans ier au carbone," N. T. Belaiew, *Revue de Métallurgie*, 1910, p. 510.

[5] See Figs 7, 8, 9, 10, 11, 12, and 13, in the previously mentioned paper they are also reproduced in M. Sauveur's book, "The Metallography of Iron and Steel," Lesson x., figs. 7–13.

[6] "When a liquid or solid deposits successively several solid phases, the secondary and tertiary deposits often preferentially lodge between certain of the cleavage planes (plans cristallographiques) of the primary deposit, and thus illustrate its structure." "Sur la Cristallisation du Fer," Osmond et Cartaud, *Revue de Métallurgie*, 1906, p. 658.—*Note by* Editor, Proc. Inst. of Metals.

[7] See also "Sur la crystallisation et structure des aciers refroidis lentement," N. T. Belaiew, *Revue de Métallurgie*, 1912, p. 321.

Following the brilliant theory of Osmond, the alloys of iron and of nickel in the case of meteorites ought to follow an analogous diagram.

Not long since this theory was entirely confirmed by the beautiful experiments of Benedicks. We see that in the two cases, in that of meteorites as well as in that of terrestrial iron, the appearance of these Widmanstätten figures is connected with two fundamental facts—the character of the primary octahedral crystallisation, and the separation of the solid solution into different phases during recrystallisation.

This structure, therefore, is not in the least confined to iron and its alloys; it might be equally well encountered in each alloy or each metal which crystallises in the regular system, and in which, after solidification, the crystallised solid solution throws out secondary deposits, that is to say, is subject to recrystallisation. In a pure metal there would be an allotropic change in the solid state, as, for example, the iron shown in Fig. 4—in an alloy, the separation of a new phase; and as diagrams of this kind are well known, it ought not to be at all difficult to find examples of the Widmanstätten structure in alloys other than iron.

To this class of alloys belong, for example, the different alloys of copper, particularly the brasses and bronzes. Gulliver, in his interesting volume on metallic alloys,[8] gives numerous examples of this, mentioning the separation of $SnCu_3$ in the alloys of copper and tin, of $SbCu_2$ in those of copper and antimony, of the constituent beta in brasses with about 35 per cent. of zinc (see Gulliver, Fig. 200), or of delta in the alloys with 70 to 75 per cent. of zinc (see Gulliver, Figs. 205 and 206). The author is able to reproduce here a photograph (Fig. 5) of a brass containing 55·1 per cent. of copper (cooled in sand and annealed), which was kindly sent to him by M. L. Guillet. This photograph has great interest, as it shows the action of reheating on the Widmanstätten structure.

Fig. 6 serves as another example of this structure, for which the author is indebted to M. Chouriguine; it represents an alloy of platinum-aluminium. M. Chouriguine,[9] in studying these alloys, found a transformation in the solid state, and this transformation manifested itself in a very marked Widmanstätten structure.

It is perhaps useful to remark that the first condition, that is to say, the primary octahedral crystallisation, is not difficult to find, for the majority of metals and alloys crystallise either in the regular or in the hexagonal system. In the last case the character of the Widmanstätten figures may differ in detail whilst preserving the same general aspect, as can be seen from Fig. 7,[10] representing a sample of zinc after melting and slow cooling.

These few examples, though taken somewhat haphazard, serve nevertheless as illustrations of the great extent to which the Widmanstätten structure exists in different alloys and metals. In the alloys of iron the Widmanstätten structure has an important industrial interest, as it gives rise to very poor mechanical properties in the case of cast steels and in overheated steels.

The chief object of this brief communication is to direct the attention of metallurgists and engineers to the study of alloys, other than iron, from the point of view of the production and the removal of the Widmanstätten structure.

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[8] "Metallic Alloys," G. H. Gulliver.

[9] "Sur les alliages du platine avec l'aluminium," by M. Chouriguine. *Revue de Métallurgie*, 1912, p. 8735.

[10] This photograph was taken by M. Timothéieff.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BELFAST.—Prof. R. H. Yapp has been appointed professor of botany in the Queen's University, Mr. C. W. Valentine professor of education, and Sir Hiram Shaw Wilkinson pro-Chancellor of the University.

GLASGOW.—Dr. W. J. Dilling, of Aberdeen, has been appointed to the new "Robert Pollok" lectureship, for research in materia medica and pharmacology, at the University of Glasgow.

The University Court has given leave of absence to Mr. A. Stevens, assistant in the department of geography, in order that he may accompany Sir Ernest Shackleton's Antarctic Expedition as geologist. The Court has also placed at his disposal a petrological microscopic equipment for the purposes of the expedition.

Temporary arrangement have been made for carrying on the work of a considerable number of the lecturers, assistants, and examiners, who, in consequence of the war, are absent on duty or detained abroad.

DR. D. A. CAMPBELL, of Halifax, has, says *Science*, promised 12,000*l*. to endow a chair of anatomy at Dalhousie University, Halifax, in memory of his son, the late Dr. George Campbell.

THE council of the Senate of the University of Cambridge has offered to professors, teachers, and students of the University of Louvain such facilities in the way of access to libraries, laboratories, and lectures, together with the use of lecture-rooms, as may secure the continuity of the work of that University during the present crisis. Hospitality in the way of living accommodation and so forth will probably be offered by the individual colleges and by private residents. The professors of the University of Oxford have offered a home for the winter to the young children of the professors of the University of Louvain; and the academic staff of University College (University of London) offers hospitality to about seventy members of French and Belgian universities, whether professors, teachers, or students, men or women, who may find it necessary to take refuge in this country.

A WELL illustrated prospectus for the present session of the Municipal Technical Institute, Belfast, has been issued. The chief object of the institute is to provide instruction in the principles of the arts and sciences which bear upon the trades and industries of Belfast, and to show by experiment how these principles may be applied to their advancement. The evening classes are designed for persons engaged during the day in handicrafts or business who desire to supplement and develop the knowledge and experience they have gained in the workshop and warehouse. It is satisfactory to notice that the prospectus insists that the successful prosecution of special studies is in proportion to the student's knowledge at the beginning of such work of the elements of mathematics and drawing. The day technical course provides instruction in the science and technology of mechanical and electrial engineering, the textile industries, and pure and applied chemistry; and it gives a sound training to youths who aim at filling responsible positions in these departments of activity. We notice that the Queen's University of Belfast and the Belfast Corporation have entered into an agreement whereby the institute is recognised as a college in which students of the University may study to qualify for a degree or diploma in science of the University. It is impossible in view of the completeness and multiplicity of the arrangements which have been made to meet the needs of every class of student, to mention them all, but attention may be directed to the public textile testing and conditioning house which has been opened at the institute. This house examines textile materials with the object of ascertaining and certifying their true length, weight, condition, and strength; and of carrying out other investigations required by merchants and manufacturers.

THE Northampton Polytechnic Institute, London, E.C., has issued its "Announcements Educational and Social for the Session, 1914–15." The announcements form a volume of 298 pages, and give full particulars of a varied and comprehensive curriculum. The work of the institute is divided into two main sections: an educational section for technological subjects, and a social and recreative section. The educational aim is to provide classes in technological and trade subjects, special attention being directed to the immediate requirements of Clerkenwell, the district in which the polytechnic is situated. Prominent among the day courses is that provided in technical optics. The aim in this department is to provide the thorough theoretical and practical training now required in various branches of the optical industry. It is believed that there is now, and that there will be for some time to come, a considerable demand for well-trained men. In connection with the practical side of this training the department has had the benefit of advice and assistance from prominent members of the optical trade. The full course as at present established extends over two years, and is divided into two sections, for opticians and optical instrument makers respectively. The engineering day college is organised in two departments for civil and mechanical engineering, on one hand, and for electrical engineering on the other. In the former arrangements have been made for the teaching of aeronautical engineering. The course in aeronautical engineering will follow the same plan as the other engineering day courses, that is, the first two years will be devoted to the subjects which form the ground work of all engineering, and the necessary specialisation will take place in the third and fourth years. These are a few examples of the practical character of the instruction given, and a reference only is possible to some of the other courses, which include watch- and clock-making and horological engineering generally, many branches of technical chemistry, and subjects connected with the jewelry, silversmiths', and metal-working trades. Evening classes on an even more comprehensive plan have also been arranged.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 7.—M. P. Appell in the chair.—G. **Bigourdan**: Observations of the Delavan comet (1913*f*) made at the Paris Observatory. Positions given for September 2 and 3. The comet was visible to the naked eye in spite of the size of the moon. It appeared to be of the fifth magnitude.—M. **Appell**: A transformation of certain functions deduced from Θ functions of higher degree.—L. **Mangin**: The polymorphism of certain diatoms from the Antarctic. It is shown that the classification of diatoms by the markings or values is faulty, since these show for a given species much less fixity than the structure of the endochrome. The paper is accompanied by numerous illustrations.—M. **Fournier**: The resistance of a fluid to the horizontal translation of a spindle-shaped body, moving in the line of the axis of the figure.—P. **Gaubert**: The faces of solution of dolomite. A study of the relations between the crystalline symmetry and etching figures produced by the action of very dilute nitric or hydrochloric acids.

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Northampton Polytechnic Institute, St. John Street, E.C. Announcements Educational and Social for the Session 1914–15. Pp. 298. (London: Northampton Polytechnic.)

Uganda Protectorate. Annual Report of the Department of Agriculture for the Year ended March 31, 1914. Pp. 67. (Kampala: Uganda Printing and Publishing Co., Ltd.)

Transactions of the Leicester Literary and Philosophical Society, together with the Report of the Council and Annual Reports of the Sections. Vol. xviii. Pp. 103. (Leicester: W. Thornley and Son.) 2*s*. 6*d*.

Poems of the Great War, published on behalf of the Prince of Wales's National Relief Fund. 2nd edition. Pp. 39. (London: Chatto and Windus.) 1*s*. net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June, 1914. Edited by Prof. A. Meek. Pp. 108. (Newcastle-on-Tyne: Cail and Sons.) 5*s*.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Fifth edition, entirely re-written and enlarged. Vol. ii., edited by G. H. Warburton. Pp. xiv+944. (London: Macmillan and Co., Ltd.) 25*s*. net.

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THURSDAY, OCTOBER 1, 1914.

PONIES, PHEASANTS, AND POULTRY.

(1) *The Shetland Pony.* By Charles and Anne Douglas. With an Appendix on "The Making of the Shetland Pony." By Prof. J. Cossar Ewart. Pp. xi + 176 + plates. (Edinburgh and London: W. Blackwood and Sons, 1913.) Price 10*s.* 6*d.* net.

(2) *Pheasants and Covert Shooting.* By Captain A. Maxwell. Pp. ix + 332 + plates. (London: A. and C. Black, 1913.) Price 7*s.* 6*d.* net.

(3) *Our Domestic Birds.* Elementary Lessons in Aviculture. By John H. Robinson. Pp. x + 317. (Boston and London: Ginn and Co.) Price 6*s.*

(1) IT was a happy thought on Mr. and Mrs. Douglas's part to write the story of the Shetland pony—a survivor of the race of small horses which was established in Britain in very early times. The winsome creature, "small, robust, gay, shaggy, alert, strong of bone, short-eared, large-eyed," may be a composite of Oriental and Scandinavian virtues, but there has been for long a definite unified race, well adapted to the natural conditions and human needs in Shetland. Sheltered by abundant mane and tail and "that waterproof double coat of thick fur and long hair which alone can maintain warmth in wind and rain and mist"; endowed with endurance and "metall past belief"; yet with "docility and sweetness of temper which make it more truly domestic than any other horse," the Shetland pony is congruent with its home. The authors have written of it with pleasure, and their book is naturally therefore pleasant reading. They tell us of the history of the modern Shetland pony, which owes much to the stud established by the Marquis of Londonderry in 1870, and much to a single individual called Jack. They describe the points of the best type, and suggest lines of progress and improvement. There is a valuable chapter on management, evidently based on long experience. The book is finely illustrated with interesting photographs.

We cannot refrain from quoting the delightful closing paragraph of a charming book on a charming subject.

"Yet in the end it is idle to deny that it is not his indisputable economic validity that binds the Sheltie's lovers to him: rather it is himself, his wisdom and his courage, his companionable ways, his gay and willing service. Having taken from him their first falls and first riding lessons, and fought with him their first battles, they look forward to an old age in which he shall draw their bath-chairs; and in the interval of life he provides as a field animal the dual charm of a creature at once wild and tame—wild in his strong instincts, his hardihood, and his independence—domestic in his wisdom and sweet temper, his friendly confidence in mankind, and his subtle powers of ingratiation."

Prof. J. Cossar Ewart has added to the value of the book by furnishing a zoological appendix on "The Making of the Shetland Pony." He comes to the conclusion that—

"Shetland ponies are mainly descended from the 'small and fleet' race yoked to the chariots of the Caledonians at the battle of Mons Graupius. This ancient race, again, was probably to begin with a blend of the slender-limbed, Arab-like ponies of the Swiss lake-dwellers, and of a thick-set race of the elephant-bed type."

As to the small size, he says:

"If Shetland ponies have not sprung from a small wild pigmy race, it may be safely asserted that their small size is mainly due to isolation in small areas where they were forced to shift for themselves under, as a rule, extremely unfavourable conditions."

(2) Captain Aymer Maxwell has written an admirable book on "Pheasants," a welcome companion to his well-known "Partridge." It is marked by competence of information, carefulness of statement, a vigorous, interesting style, and sound judgment on vexed questions. It is embellished by numerous charming coloured pictures by Mr. George Rankine. Most of the chapters are of course practical, dealing with the rearing of birds, the care of coverts, the shooting, the inevitable conflict of interests between fox-hunting and pheasant-preserving, and similar subjects. In connection with covert-shooting, the duck comes in for a chapter. The first three chapters of the book are devoted to questions of natural history—the different kinds of pheasants, their habits, and their history. The Colchican pheasant, now uncommon in Britain, was introduced by persons unknown before 1000 A.D., and remained in undisturbed possession until the end of the eighteenth century, when the ring-necked species was introduced from Southern China. Thereafter came Japanese pheasants, Mongolian pheasants, and more besides; and as most of them interbreed freely, our "common pheasant" is a vigorous mongrel which may combine characters of four or five species. The author has interesting notes on many subjects: the wild traits persisting in reared pheasants, the rate of flight—rather under forty miles an hour, the power of swimming, the cock's dangerous custom of proclaiming where he settles down for the night, the pheasant vocabulary, the courtship, the suppression of scent when

the hen-pheasant is sitting, the miscellaneous diet, the assumption of male plumage by hens, the crossing with capercailzie, blackgame, guinea-fowl, and poultry. We are not forgetting that this is not the first book on the pheasant, but it is written with freshness and first-hand knowledge, and should enjoy a deserved popularity.

(3) We are much behind the times in Britain as regards aviculture, and it is to be hoped that Mr. John H. Robinson's very competent book will serve as a stimulus. It has been computed that the annual production of poultry in the United States approaches the value of a thousand million dollars, and Mr. Robinson shows that there is pleasure as well as profit in the business. We do not think that anyone can read his book without wishing more power to the elbow of those who have been active in recent years in increasing and improving poultry-keeping in this country. It should be noted that Mr. Robinson's book is actually meant for schools, and that he defends this on educational as well as on utilitarian grounds. His enthusiasm is not damped by any thought of the danger, probably in great part a bogey, of tethering school-children too early to the practical problems of life. A second book of a purely technical character is, we understand, being prepared; the object of this one is:

> "To tell in plain language the things that everyone ought to know about poultry, pigeons, and cage birds; to teach fundamental facts in such a way that they will be fixed in the mind; to excite interest in the subject where none existed; and to direct enthusiasm along right lines."

Mr. Robinson is not afraid of what his fellow-countrymen sometimes call "hen-fever."

The book deals in a robust practical way with fowls, ducks, geese, turkeys, guinea-fowls, pea-fowls, pheasants, swans, ostriches, pigeons, and canaries and it seems to us to fulfil its purpose. Our only suggestion is that, before a second edition is printed, the author should get some zoological friend to read over the general introduction, which is not without blemish. If aviculture is to be a school-subject, its presentation should be scrupulously accurate. Therefore, some changes should be made in statements such as the following: "Many insects and one species of mammal (the bat) fly." "Man learned melody from the song birds." "These yolks are not germs, but as they grow the germ forms on one side of each yolk, where it appears as a small white spot." These are merely examples of different kinds of statements which admit of improvement. On page 35 it is indicated that the theory of the origin of domestic fowl from the Indian jungle fowl is no longer tenable, but we would refer the author to a well-known American ornithologist, Mr. C. W. Beebe, who wrote in April of this year: "I can find no reason to attribute the ancestry of all varieties of our domestic fowls to other than the red jungle fowl of India, *Gallus Gallus* (Linnæus)." We have not observed any reference to Mendelism in Mr. Robinson's book, but we suppose the omission must be deliberate. If so, one would like to know why.

SILICA AND SILICATES

La Silice et les Silicates. By Henry Le Chatelier. Pp. 574. (Paris: A. Hermann et Fils, 1914.) Price 15 francs.

SILICA, as is well known, constitutes a large proportion of the earth's crust, and in some form or other plays a very important part in commerce and industry. Silica and silicates are largely used as material for building purposes, for pottery, glass, cement, fluxes, etc. Their full importance is perhaps not brought out in the ordinary text-books; comparatively little is said about them in most books on chemistry and, on the other hand, while in treatises on mineralogy a considerable proportion of the pages are devoted to this large mineral group in their scientific aspect, their practical applications are almost wholly ignored. Prof. Le Chatelier's work is therefore very welcome, especially since it is from the pen of one who has himself done so much to extend our knowledge of the physical properties of the products of these materials.

After a short introduction, in which he epitomises the scope of the book, the author enters into a full description of the characters of the anhydrous and hydrous forms of silica, typified respectively by quartz and chalcedony, and by opal; the rare tridymite and cristobalite are, however, also discussed. Apart from jewelry, quartz is invaluable in saccharimetry and microscopy, and in recent years an extremely important use has been discovered for it in its amorphous form. The excellence of quartz fibres for torsional purposes was pointed out by Boys a quarter of a century ago, and his ingenious method of preparing them has never been improved upon. For vessels likely to be subjected to rapid and considerable changes of temperature amorphous quartz far surpasses glass, and finds extensive use at the present day. Next in a series of five chapters the properties and peculiarities of the principal different varieties of glass are fully discussed.

The various silicates are described in the following series of chapters, but the characters of most of the species are only summarised briefly, greater space being allotted to those of commercial importance. Considerable attention is, of course, given to china-clay, and this chapter paves the way for an important one on pottery. Incidentally in these chapters many questions of scientific importance are discussed; for instance, solid solutions, mixed crystals, hydrated salts, and the classification of the silicates; Prof. Le Chatelier himself adopts in this book a chemical classification. The admirable work done at the Geophysical Laboratory, Washington, on the artificial production of certain groups of silicates and the determination of their properties, receives adequate treatment. In the concluding chapter the author reviews very briefly the principal rocks and their classification, and the fluxes.

The book is well printed, but, like French books in general, is issued unbound and with uncut leaves. It unfortunately lacks an index.

NEW BOOKS ON CHEMISTRY.

(1) *Modern Steel Analysis.* By J. A. Pickard. Pp. viii+128. (London: J. and A. Churchill, 1914.) Price 3*s.* 6*d.* net.

(2) *The Synthetic Use of Metals in Organic Chemistry.* By A. J. Hale. Pp. xi+169. (London: J. and A. Churchill, 1914.) Price 4*s.* 6*d.* net.

(3) *A Third-Year Course of Organic Chemistry.* By Dr. T. P. Hilditch. Pp. xii+411. (London: Methuen and Co., Ltd., n.d.) Price 6*s.*

(4) *The Viscosity of Liquids.* By Dr. A. E. Dunstan and F. B. Thole. Pp. vii+91. (London: Longmans, Green and Co., 1914.) Price 3*s.* net.

(5) *Intermetallic Compounds.* By Dr. C. H. Desch. Pp. vi+116. (London: Longmans, Green and Co., 1914.) Price 3*s.* net.

(6) *De la Pirotechnia* (1540). By V. Biringuccio. A Cura e con Introduzione di A. Mieli. Vol. i. Pp. lxxxv+198. (Bari: Società Tipografica Editrice Barese, 1914.) Price 3 lire.

(1) THE little volume by J. A. Pickard is one which may be safely recommended to those who are engaged in iron and steel analysis. The introductory chapter might indeed be read with advantage by any analytical chemist whatever his speciality. The sodium bismuthate method for the estimation of manganese is fully described, and the volumetric methods for the estimation of phosphorus, nickel, and chromium, in short, the various processes, so far as the writer can judge, are well up-to-date. It may be observed that the author does not mention the use of porcelain funnels or Gooch crucibles, but recommends pulp filters laid over perforated discs in ordinary funnels. It is impossible to say without experience what advantage the pulp filter has over well-fitting paper discs in a small Buchner funnel, but from the description the former seems the more troublesome arrangement. No reference is made to the moist combustion method described many years ago by Turner in which the carbon was filtered through asbestos and ignited sand contained in a hard glass tube and burnt *in situ*; for Turner's method seems more convenient and accurate than the process described here, involving the transference of the carbon and filter to the combustion tube.

(2) The rapidly increasing use of metals in organic synthesis in recent years has expanded the literature to such dimensions that something in the form of a summary of the methods has become almost imperative, and it is a significant fact that books on the synthetic use of metals have appeared almost simultaneously in both German and English.

The small volume by A. J. Hale includes all the more important methods, which, though not described exhaustively, are thoroughly typical and sufficiently elaborated to render the various processes easily understood. References are also given to the original literature, so that the reader may always supplement his knowledge by turning to the original source. The plan of collecting them at the end of the chapters involves a certain inconvenience, for it necessitates constantly turning over pages, and, as the authors' names are omitted, one is occasionally left in ignorance of rather interesting, if not indispensable, information. The proper place for a reference is surely on the same page as the subject referred to.

(3) The volume on organic chemistry by Dr. Hilditch is the third and last of the series of text-books on this subject which have been prepared for the use of technical institutes. It contains chapters on heterocyclic compounds, the purine group, polypeptides, carbohydrates, terpenes, and the alkaloids.

It would perhaps be more correct to call it a book of reference than a third-year text-book; for it is so closely packed with facts and formulæ that it would tax the powers of an exceptionally good memory to assimilate a fraction of the material in one year. It might also be added that the lettering of the formulæ, especially of the ring compounds, is a severe strain on the eyesight, and might be printed in larger type with great advantage. The book has, however, been carefully and thoughtfully compiled, and should prove useful not only to students of technical institutes and university colleges, but to others who have an interest in the more intricate branches of organic chemistry.

(4) Among the more valuable of the series of monographs on inorganic and physical chemistry published under the editorship of Prof. Findlay is the volume on the viscosity of liquids, by Dunstan and Thole. The subject is, in a sense, in an elementary stage, but the foundations have been laid, and the results, which have been obtained by the authors who may be looked upon as pioneers in this branch of physical chemistry, promise a valuable aid in elucidating many interesting problems. As the authors state in the preface, the additive effect of a physical property is of little use for the purpose of studying structure; but viscosity, like optical rotatory power, is mainly constitutive, and the difficulty in both cases lies in the interpretation of the numerical values.

The various chapters describe the apparatus, methods of measurement and of calculation, the measurement of the viscosity of pure liquids, of mixed liquids, of electrolytic solutions, colloidal solutions; and the final chapters are devoted to discussing the relation of viscosity to chemical constitution.

It is impossible in the short space allotted to this review to discuss the results; but the volume is a unique contribution to chemical literature, and well worth reading.

(5) The monograph on intermetallic compounds, by Dr. C. H. Desch, has reference to those mixtures of metals which form true compounds, and the methods by which such compounds may be distinguished from simple alloys. That the subject is an intricate one may be judged from the numerous erroneous results which marked the first attempts in this direction, and bv the not altogether satisfactory character of the present available data. The first accurate investigations were made by Heycock and Neville in 1897 by means of the freezing-point curve, and these have been followed more recently by the work of Tammann and his pupils. That the subject has been very widely studied may be seen by the long list of references, more than 200 in number, which are given at the end of the volume. The chapters are divided into the following subjects: thermal analysis, microscopic structure, the isolation of intermetallic compounds, their physical properties and chemical nature. The subject is one of the first importance to metallurgists, to whom this excellent and complete summary should make a special appeal.

(6) "De la Pirotechnia," of Biringuccio, of which the present volume is a reprint, appeared in 1540, the year following the death of its author. It has been edited and annotated by A. Mieli, who has also added a valuable introductory and biographical notice. As the name of Vannoccio Biringuccio is little known to English students of chemical history, it may be stated that he was born at Siena in 1480 and died in 1539. His father was an architect, but the son devoted his attention chiefly to metallurgy and mining, and paid several visits to Germany and Austria and other countries in pursuit of his studies. In the disturbed state of Italy at this period, when the Italian towns were constantly in conflict, the fortunes of those who allied themselves with the ruling families were apt to suffer. It is not surprising to find that Biringuccio was twice banished from his native city, when his patrons, the Petrucci, got into hot water, and was also twice recalled.

He was a contemporary of George Bauer (Agricola), whose great work on mining and metallurgy, "De Re Metallica," appeared a little later; for in it a reference is made to Biringuccio, in which Agricola recognises the debt he owes to the work of his predecessor.

Mieli, in his introduction, comparing the work of Agricola with that of Biringuccio, says:

> "In Agricola we have the mineralogist and metallurgist, and in certain respects the geologist. Agricola was a man of much erudition, and his work is full of classical references. But Biringuccio was something more. Not only do many portions of the book attest a profound knowledge of chemistry; but they reveal the artist, the craftsman, and the inventor. If Agricola has observed and described, Biringuccio has manufactured and invented new methods and machines, and shown his artistic temperament in the production alike of big and little things. He could cast a cannon as well as a church bell."

OUR BOOKSHELF.

Memorials of Henry Forbes Julian. Written and edited by his wife, Hester Julian. Pp. xix + 310. (London: C. Griffin and Co., Ltd., 1914.) Price 6*s*. net.

Henry Forbes Julian, sprung from a Scoto-Irish family, was born at Cork in 1861. During his childhood his family migrated to Bolton, in Lancashire, and there his taste for scientific research was aroused under the teaching of Sir Henry Roscoe at Owens College, Manchester. He began his life as a metallurgist and mining engineer in South Africa, where he did much exploring in the Barotse country, and visited the falls of the Zambezi. He devoted himself to developing the cyanide process of ore reduction, and in collaboration with Mr. E. Smart wrote a standard treatise, "Cyaniding Gold and Silver

Ores." In 1894 he carried out further research on behalf of the Frankfurt Gold und Silber Scheide-Anstalt, and as a consulting metallurgist made repeated voyages to Mexico and other parts of the American continent.

Mr. Julian was a man of wide scientific knowledge, a constant attendant at meetings of the British Association, and other scientific societies, and he had acquired a wide knowledge of literature. A modest, cheerful man, he made hosts of friends, and after his marriage to a daughter of William Pengelly, the well-known geologist and explorer of Kent's Cavern, his home at Torquay became the centre of much scientific and literary activity. On his last voyage to America, on work connected with a patent case, he perished in the wreck of the *Titanic*. Though few details of this final tragedy are available, he certainly displayed the heroism and unselfishness which were the leading characteristics of his life.

In the present memoir compiled by his widow the material is thin, and some of the less important incidents of his life are described with more detail than is necessary. But in the circumstances this is excusable, and the memoir gives a vivid sketch of a life devoted to the cause of science and of an amiable and attractive personality.

A Practical Handbook of the Tropical Diseases of Asia and Africa. By Dr. H. C. Lambart. Pp. xv + 324 + plates. (London: C. Griffin and Co., Ltd., 1914.) Price 8*s*. 6*d*. net.

WE are told in the preface that "the intention of the author has been to show at a glance, by its alphabetical arrangement, the diagnosis and treatment of the principal tropical diseases; the subjects treated will be found stripped to essentials, and the pages nowhere encumbered with disputed points or theories still *sub judice*, the book thus being arranged for readiest reference."

Such works are seldom to be recommended, because they involve too brief and fragmentary a treatment of subjects which must be dealt with thoroughly if they are to be understood at all; and they are to be recommended still less in medical matters, which are concerned with the life or death of patients. Medical men in the tropics have enough time at their disposal to read at least much fuller text-books than this one, which is apparently designed for the most cursory of readers. Thus, the vastly important clinical theme of abscess of the liver, requiring the utmost care in diagnosis and in medical and surgical treatment, is dealt with in three pages (without mention of Rogers's emetin treatment); and the junior medical man who would trust to this brief note alone might go very seriously wrong.

The author, moreover, can scarcely be commended for the carefulness of his abstracts, or for his grammar, his drawings, or, indeed, his general design, and the accuracy of many of his statements is open to question. The whole work suggests a compilation taken down from previous text-books or from lecture-notes; and the number of similar books on the same subject is already too large.

Leitfaden für Aquarien- und Terrarien-Freunde. By Dr. E. Zernecke. 4, ganzlich neu bearbeitete Auflage von C. Heller und P. Ulmer. Pp. vii + 456. (Leipzig: Quelle and Meyer, 1913.) Price 7 marks.

DR. ZERNECKE'S handbook for the amateur management of aquaria and the like is full of valuable information. It pays sufficient attention to amphibia, lizards, snakes, and such small deer, and it touches on the salt-water aquarium, but its full strength is concentrated on the popular fresh-water aquarium. Full directions are given for the installation, aeration, sanitation, and general maintenance of this humanising educational instrument, and a host of water-plants, fishes—both native and exotic—and invertebrates of all kinds are introduced with suitable credentials and attractive portraits.

The Continents and Their People: Africa, a Supplementary Geography By J. F. and A. H. Chamberlain. Pp. vii + 210. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1914.) Price 3*s*.

THIS book provides an account of Africa and its people which serves to supplement the more technical descriptions of the text-book. Opportunity is taken to give a full treatment of the industries dependent on dates and diamonds. The nomenclature of the States should have been brought up to date, and the account of the causes of the Nile flood should be revised.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Determination of Sex in the Gall-fly, "Neuroterus lenticularis" ("Spathegaster baccarum").

IT is well-known that many Cynipid gall-flies of the genus Neuroterus (Spathegaster) have two generations in the year, one generation of parthenogenetic females and a second generation of males and sexual females. I have previously shown (Proc. Roy. Soc., B lxxxii., 1910, p. 88, and B lxxxiii., 1911, p. 476) that any individual parthenogenetic female has either only male or only female offspring, and that the eggs of the male-producers undergo maturation of a different type from those of the female-producers. I suggested that possibly the determination of male-producing or female-producing individuals depended on the existence of two kinds of spermatozoa. Further experiments extending over the last two years have shown that this suggestion is mistaken, and that the difference between the male-producing and female-producing parthenogenetic females is derived from the sexual female parent. It will take several months at least to complete the cytological investigation of the phenomena which I have in hand, and therefore it may be of interest shortly to record at once the results of the breeding experiments, for they show a type of sex-determination not previously known in the Hymenoptera.

The experiments indicate that any individual sexual female produces either only male-producing or only female-producing parthenogenetic offspring, but not both. Individual fertilised females were allowed to lay on sleeved oak-leaves in May, 1913; the galls produced by each were collected, and sleeved on oak leaves in March of this year. On examining the flies produced, I found that, with a few possible exceptions, the grandchildren of any one sexual female are either all males or all females. I have examined more than 9000 grandchildren of the twelve fertilised females sleeved in May, 1913, and among these there are about 2 per cent. of exceptions to the rule that all the grandchildren of any sexual female are of the same sex. The exceptions, however, do not occur in all the sleeves, but in rather less than half, and I have little doubt that they are due to wild flies having been able to lay eggs in the buds through the muslin of the sleeves. The wild flies were exceptionally abundant this spring, and it is difficult to prevent the buds from pressing against the muslin in such a way that a fly on the outside could not lay in them. I intend to test this possibility next spring, but meanwhile the results obtained make it certain that nearly, if not quite all, the grandchildren of any sexual female are of one sex, and that of the sexual females, those which have male or female grandchildren are about equally numerous.

L. Doncaster.

Cambridge, September 21.

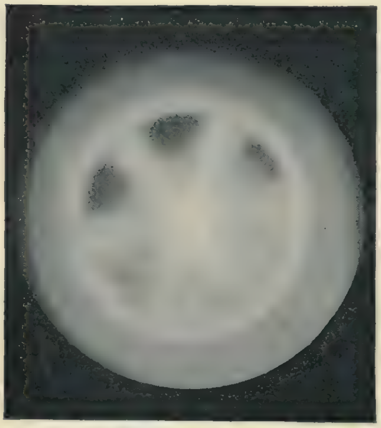

Fig 1.—Asymmetric. Extreme X-rays (Grazing anti-kathode) 70° from normal in plane at right angles to that of kathode rays.

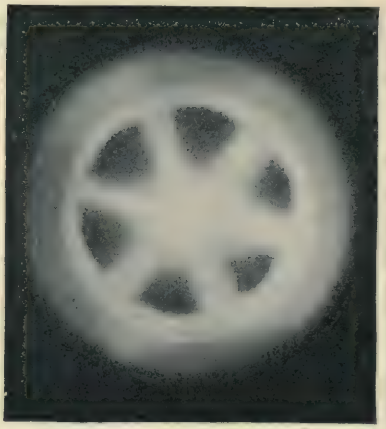

Fig. 2.—Symmetric. Optimum X-rays 15° from true reflection and in plane of kathode rays, *i.e.*, 30° from normal to anti-kathode.

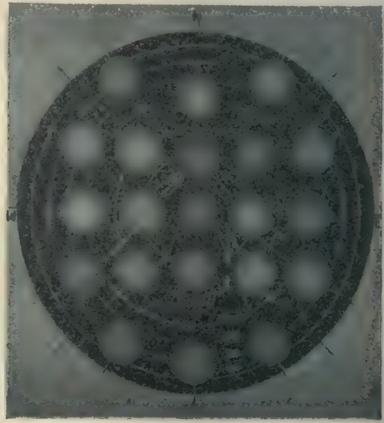

Fig. 3.—Map of hemisphere of X-rays (lead disc) showing radial structure of radiation. Reduced 4 diameters.

Asymmetric "Diffraction" and "Re-Diffraction" of X-Radiation.

Further work upon this subject, briefly described in previous letters (see Nature, July 16, p. 507), has shown that for any one position of the bulb and object the angle of diffraction is constant. This angle, however, varies with the distance of the object from the source in accordance with a simple inverse sine-law ($\sin\theta \times dcm = 7{\cdot}5$), over the wide range of 8° to 40°, and 50 to 10 cm. This and other well-marked differences from light have been already noticed in our previous papers, and a table of the sine values is given in the present (October) number of the *Röntgen Journal.*

A map of the hemisphere of X-rays, charted by the diffraction images of a lead disc, shows that there is an "optimum," or axis of symmetry, lying in the plane of the kathode rays and 30° from the normal to the anti-kathode (Fig. 3.). Around this axis the effects are increasingly asymmetric. This is shown by the variation of the white band (from a full circle to nearly a semi-circle) within the shadow, and of a dark area between it and the boundary of the image. The positions of maximum intensity have been determined by the photographic and electroscopic methods (see Nature, August 13, *Röntgen Journal,* July and October, 1914), and are found to be always directed to the optimum axis. The asymmetry has also been established with V-apertures and squares of metal, where the white band appears on one, two, or three (asymmetric), or four sides (symmetry) according to the relative positions (70° to 0°) to the axis of symmetry. The bulb must, of course, be rotated on the spot as centre. In addition to these effects, already described, we have now ascertained that the "diffracted" rays are almost entirely re-diffracted by a second edge. The re-diffraction (as in the case of primary diffraction probably) occurs in two directions, *i.e.* within and without the shadow. Moreover, these effects are again definitely asymmetric when other than optimum rays are used. For instance, a lead disc perforated by apertures symmetrically arranged is shielded by a solid disc of slightly larger dimensions to secure that no rays except those already diffracted by it can reach the second disc. The perforated disc may be placed 0·7 cm. from the plate, and 19 cm. from the anti-kathode, 2·7 cm. separating the discs.

These rays, being normal to the disc, and leaving the anti-kathode at any other than the optimum angle, the images of the perforations will be seen (Figs. 1 and 2) to be increasingly displaced, distorted, and altogether absent in the extreme position. The asymmetry is marked at *opposite points,* and not at the ends of rectangular axes as would be the case were the phenomenon one of *ordinary* polarisation.

A black band *outside the shadow* is naturally only observed when the rays are thus shielded, for otherwise it falls in the area of undiffracted direct radiation.

In these experiments especial care has been taken to keep the milliamperage constant between 1 and 1·5, by means of a variable resistance in the primary.

I. G. Rankin.
W. F. D. Chambers.

90 Gordon Road, Ealing.

GLASS FOR OPTICAL PURPOSES.

THE importance of an adequate supply of optical glass of all the principal types cannot be overestimated. The improvement of the microscope has been and is still retarded for the want of suitable glasses, the construction of large telescopes is limited by the capacity of the glassmaker to supply suitable discs of glass, and the improvements made in the design of small telescopes cannot be extended to larger sizes for the want of suitable glass.

Photographic lenses, binoculars, range-finders, and telescopes of all kinds are dependent for their performance on the good quality, both optically and physically, of the glass used in them. The magnitude of this special branch of the glass-making industry may be gauged from the value of the German exports. In the last year for which figures are available the value of the exports of unworked optical glass exceeded fifty thousand pounds, and large quantities were exported as finished lenses. The characteristic of optical, as distinguished from other glass, is its great homogeneity; veins of material of different composition even in the form of very fine striæ render glass unsuitable for the better class of optical work.

The history of optical glass-making is to a large extent the history of optical progress. Dollond's discovery of the achromatic combination (1757) created a demand for flint glass suitable for optical purposes. At first this demand was met by the selection of the most suitable pieces from the glass manufactured for other purposes, but the demand for larger discs of flint glass led Guinand (1748–1824) to work out new methods of melting flint glass. The essential feature of his method was the continual stirring of the glass to prevent the formation of striæ of different density. Guinand migrated from Switzerland to Bavaria, and in conjunction, first with Utschneider and later with Fraunhofer, improved the process, so that larger blocks of good uniform glass could be manufactured regularly. On Guinand's return to Switzerland, Fraunhofer continued his experiments, and was able subsequently to make good discs of flint glass up to 10 in. in diameter. Meanwhile Guinand had increased the size of discs up to 14 in. diameter, and on his death in 1824 the secret passed to his sons, and through them to Bontemps in France. Bontemps' work was carried on by the French house of Feil, now Parra-Mantois, while Bontemps himself brought the secret process, in 1848, to the glass-works of Messrs. Chance.

For some time the principal advance was in the improvement of the physical properties of the glass, greater uniformity, greater transparency and more durability being aimed at. The calculation of the Petzval portrait lens and its successors led to a large demand for a glass intermediate in type between the ordinary flint and the crown. For this purpose, and for use in the other types of photographic lenses, the series of light flints was worked out. In this series the percentage of lead oxide increases as a higher refractive index is required.

The progress of the microscope makers required the extension of this series of glasses to denser flints, *i.e.* glasses of higher refractive index; at the same time small variations in the constitution of the crown glass were made to give slightly differing optical properties. In this way, by the year 1880 it was possible to make a complete series of glasses with their refractive indices ranging from 1·515 to 1·72. But these glasses had two special characteristics: as the refractive index increased, the dispersion, *i.e.* the difference in the refractive indices for light of two chosen colours, increased more rapidly, so that it was always necessary to use the glass of lower refractive index for the positive lens of an achromatic combination; also the dispersions of two glasses of different refractive index were not proportional throughout the spectrum, so that if a combination of a crown and a flint lens were made to bring the red light proceeding from an object to the same focus as the blue light, the yellow and violet light would not come to the same focus. The consequence was that all images appeared coloured, in spite of the choice of the most suitable curves for the two lenses; this defect is termed "secondary spectrum."

Many attempts had been made to obtain a pair of glasses which would enable the lens-maker to get rid of this secondary spectrum. The experiments of the Rev. W. V. Harcourt (1789–1871), which extended from 1834 to 1871, showed that this problem could be solved; he proved that the effect of substituting boric acid for part of the silica in the glass was to reduce the dispersion of the blue end of the spectrum, and so to make a flint glass which more nearly matched the ordinary crown glass. He was also able to modify the crown glass by using phosphoric acid, but wrongly attributed the result to the presence of titanic acid. Unfortunately these experiments did not lead to practical results, probably because of the expense attaching to experimental meltings on a practical scale.

The next stage in the development of optical glass was the investigation by Schott and Abbe (1881–1886) of the effects of using different materials. With consummate experimental skill, and assisted by generous grants from the Prussian Government, they were able to determine the effects of employing different materials. They were able to confirm Harcourt's results as to the action of boric acid, and correctly to attribute the effects observed by him to phosphoric acid. In addition, they were able to determine the effects of barium both with and without boric acid.

Now the use of boric acid in the ordinary lead glasses always leads to a glass which is more or less liable to spot, but by the use of barium instead of some of the lead this effect is reduced. The boric acid barium glass is, however, of special value, because in this case a high refractive index is associated with a low dispersion. It behaves as a crown glass as regards its dispersion, but as a flint glass in respect of its refractive index. This property is of special value in the construction of modern anastigmat photographic lenses. These researches of Schott and Abbe were followed by the establishment of the Jena glassworks, where the new types of glass were made on a commercial scale.

The immediate results were—

(1) The manufacture of flint glasses containing boric acid; by the aid of these glasses it was possible to make three-lens objectives free from secondary spectrum, but these glasses are not so permanent as the older types.

(2) The series of phosphate glasses which proved chemically unstable and deteriorated in use.

(3) The boro-silicate crown glasses, which are of somewhat lower refractive index and dispersion than the ordinary crown glass. These are good glasses, and are now extensively used for small objectives and for the prisms used in prism binoculars.

(4) The dense barium crown glasses, containing barium and boric acid. These glasses are used in nearly all anastigmat photographic lenses, but they are difficult to make because such abnormal optical qualities are closely associated with chemical instability.

(5) The most important result was, however, the possibility of obtaining a large range of refractive index and dispersion, so that the designer was able to regard the dispersion and refractive index as more or less independent of each other.

He could design a photographic lens with little regard to the chromatic defects and correct this defect by proper choice of the dispersion of his glass.

These great successes led at first to a concentration of the optical glass industry in Jena, but the success of Chance in improving the quality of the older types of glass, and of Mantois in making the newer types, have somewhat modified this situation, though we are still dependent on Jena for some of the special glasses.

The manufacture of optical glass is not, however, to be lightly undertaken; there would be no great difficulty in finding the composition of glasses of the existing types, though it must be remembered that the mixture used will differ somewhat in composition from the final product. Great difficulties are associated with the purity of the materials and their proper mixing; the pots must be of clay, free from impurities which might colour the glass. The preparation of these pots requires skilled workmen of long experience, and the same may be said of the melting temperatures, the proper period of stirring, the rate of cooling, and the whole annealing process. At the same time, small variations of composition or treatment will affect the optical properties quite considerably. The experimental work associated with the production of special types of glass is expensive and troublesome, since the principal difficulties arise when we endeavour to change from the laboratory to the works scale, and at this stage a single failure may cost fifty pounds.

In view, however, of the importance to our industries and to the army and navy of an adequate supply of optical glass of various types, it is most desirable that our optical glass should be made in this country, and the manufacturers should be encouraged in every way to meet this demand. Success in this direction is, however, most likely to be achieved by scientific experimental work carried out in conjunction with those manufacturers who have already acquired valuable and essential experience in the manufacture of optical glass. S. D. CHALMERS.

THE BRITISH ASSOCIATION IN SOUTH AUSTRALIA.

ADELAIDE, AUGUST 12.

THE Australian meeting of the British Association opened in Adelaide on Saturday, August 8. The main party of overseas members arrived by the Orient mail steamer *Orvieto*, and numbered 150. It included the majority of the "advance party" to Western Australia. A smaller party of fifty members had arrived by the Blue Funnel steamer ***Euripides*** on the previous evening, and members arriving by other and earlier routes raised the total to approximately 290 overseas members. The local membership roll fell but a single unit short of 600 members, a figure significant of the keen interest taken by the people of South Australia in the advent of the Association.

The Adelaide meeting has been favoured with perfect weather, and only the outbreak of the war cast its gloom over a meeting which otherwise fell nothing short of complete success.

On the afternoon of arrival a special congregation was held by the University of Adelaide, when the following honorary degrees were conferred:—*D.Sc.*—Prof. W. J. Sollas, Prof. A. Penck, Prof. T. W. Edgeworth David, Prof E. W. Brown, Sir Oliver Lodge, Prof. H. Jungersen, Prof. G. W. O. Howe, Dr. C. F. Juritz, and Prof. von Luschan. *M.D.*—Prof. G. Elliot Smith. *M.A.*—Mr. A. D. Hall, Prof. A. P. Coleman. *B.A.*—Sir Charles P. Lucas. *B.Sc.*—Prof. T. Hudson Beare.

In the same evening a reception was given to the overseas members by the State Government, when the visitors were welcomed by his Excellency Sir Henry Galway, Governor of South Australia, and by Mr. Peake, its Premier.

Owing to the short space allotted to the Adelaide Session, sectional meetings were not included in its programme. Presidential addresses were, however, delivered in geography by Sir Charles Lucas and in agriculture by Mr. A. D. Hall.

Two evening discourses were also given in the Adelaide Town Hall by Sir Oliver Lodge, on "The Ether of Space," and by Prof. J. W. Sollas on "Ancient Hunters." Both were listened to with keen appreciation by a large audience.

The major part of the Adelaide programme was occupied by excursions, which were well patronised by the visiting members. On the day of arrival a party of fourteen left Adelaide for an excursion to Broken Hill and the smelting works at Port Pirie. On Monday morning about fifteen members departed, under the leadership of Mr. Walter Howchin, to visit places of geological interest to the south of Adelaide, chief among their objects of investigations being the remarkable evidences of glaciation discovered by Mr. Howchin. On the same day a botanical excursion to the hills in the vicinity of Adelaide, under the leadership of Prof. T. G. B. Osborn, and an anthropological excusion to Milang on the shores of Lake Alexandrina to inspect a party of aborigines there, was made under the guidance of the veteran ethnologist, Prof. E. C. Stirling, who is also the chairman of the local reception committee.

On Tuesday, August 11, a second botanical excursion by motor-car to Mannum on the Murray was made by about a dozen members, and an excursion to Roseworthy Agricultural College by about twenty-five more. Members who did not participate in other excursions were conveyed on Monday by special train to Angaston, a small town fifty-one miles from Adelaide and the centre of a very important viticultural industry, where they were entertained at luncheon by Mr. Charles Angas.

On Tuesday a large number of members were entertained to luncheon by the Adelaide branch of the Commonwealth Club. On Wednesday afternoon, August 12, overseas members departed in three special trains for Melbourne.

DR. H. J. JOHNSTON-LAVIS.

Henry James Lavis, who was descended from a Huguenot family settled in Devonshire, and added his mother's name to his own, was born on July 19, 1856, and was unfortunately killed in a motor accident near Bourges, department of Cher, on September 10. After receiving his early education in a private school, Johnston-Lavis commenced his medical education at University College, London, and here came under the influence of Prof. John Morris, from whose teaching he acquired a passion for geological studies. Joining the Geological Society when only nineteen years of age, he had written several geological papers, one of them published in the Journal of the Geological Society, before he was twenty-one. After obtaining his degree of M.R.C.S. in London and holding some minor medical posts in this country, he proceeded in 1880 to Naples, where he established himself as a consulting physician, taking the degree of M.D. in the University of Naples in 1884, and acting as medical officer to Sir William Armstrong's works at Puzzuoli from 1892 to 1897.

It was at Naples that Johnston-Lavis found his most useful sphere of geological labour; besides keeping a diary with photographic records of the action of Vesuvius, he prepared a valuable geological map illustrating the past history of the volcano, with petrological studies of its ejected materials. Incidentally, these studies led to one of his most important memoirs, undertaken in conjunction with Prof. J. W. Gregory, in which the non-organic origin of the one-time famous *Eozoōn canadense* was finally demonstrated.

In addition to his studies of Vesuvius, Johnston-Lavis did much useful work in connection with the vulcanology and seismology of the whole South Italian region. Between the years 1892 and 1897 Johnston-Lavis was in the habit of spending his summers at Harrogate, where he acted as a consulting physician. In 1895 he left Naples and, having taken a degree of M.D. at Lyons, established a practice on the Riviera at Beaulieu, while in 1909 he added to this a summer practice at Vittel in the Vosges. His scientific energies never flagged, and more than 160 papers—on volcanoes, earthquakes, mineral waters, and medical subjects—were issued by him, some of them dealing with important theoretical questions. Many geologists and others who visited the Mediterranean area were indebted to Johnston-Lavis for the friendly and valuable aid which he was always ready to afford.

NOTES.

The death is announced, at seventy-five years of age, of Dr. A. S. Bickmore, formerly curator of the American Museum of Natural History, New York.

In consequence of the closure of the Anglo-American Exhibition, the visit of the Geologists' Association to the science section, arranged for October 10, will not take place.

Dr. Henry Owen, treasurer of the National Library of Wales, has been appointed a member of the Royal Commission on Ancient Monuments in Wales, in succession to the late Sir Edward Anwyl.

The death is announced, by accidental drowning, of Dr. L. C. P. Ritchie, late president and secretary of the Royal Medical Society of Edinburgh, and the author of a number of papers on medical subjects.

Announcement was made in Nature of August 20 that, in consequence of the war the publication of the "British Pharmacopœia" had been postponed. The General Medical Council has resolved that advance copies should be made accessible to the public for inspection at the offices of the council in London, Edinburgh, and Dublin on October 1, at 10 a.m., and thereafter from 10 a.m. to 4 p.m. daily. The work will be published at the end of the year.

The council of the Junior Institution of Engineers has elected the Marquess of Graham as president of the institution for the year 1914–15, in succession to Sir Boverton Redwood, Bart. The Vickers prize, consisting of a gold medal and premium of instruments or books, has been awarded to Mr. James Richardson, for his paper on high-power Diesel engines: their development for marine service. Mr. Richardson has also been awarded the institution medal for the same paper.

THE Board of Trade has arranged for a Commission consisting of representatives of the Board of Trade, the Timber Trade Federation of the United Kingdom, and the Mining Association of Great Britain, to proceed to Canada and Newfoundland in order to inquire into the possibility of opening up new sources of supplies of mining timber for use in the coal mines of Great Britain. Inquiries on the subject should be addressed to Mr. C. F. Rey, Board of Trade, Queen Anne's Chambers, Westminster.

THE death is reported of Dr. W. L. Dudley, a prominent American chemist. He was born in Kentucky in 1859, and was professor of chemistry and toxicology at Miami Medical College, Ohio, from 1880 to 1886. In the latter year he was appointed to the chair of chemistry in Vanderbilt University, where in 1895 he became dean of the medical department also. He was secretary to the inorganic chemistry section of the St. Louis Congress in 1904, and U.S. Commissioner to the London Congress of Applied Chemistry in 1909. Dr. Dudley had devised an important process for working and electroplating with iridium.

THE war is likely to lead to some readjustment of the trade of the world. The Decimal Association points out in a letter we have received that if British manufacturers are to secure any of the trade which Germany has hitherto carried on with neutral countries, they must be prepared to adopt metric measures of weight, and so on. The association will be glad to help manufacturers and merchants who need assistance, and, if there is a demand, to arrange lectures under the auspices of chambers of commerce during the coming winter. Communications should be addressed to the secretary of the association at Finsbury Court, Finsbury Pavement, London, E.C.

THE death occurred, on September 20, of Mr. William Ascroft, of Cheyne Walk, Chelsea, in his eighty-second year. Mr. Ascroft was responsible for the six beautiful crayon sketches of twilight effects published by the Royal Society in the report on the eruption of Krakatoa in August, 1883. In the November following, the extraordinary twilight glows in the British Isles commanded general attention, and their probable connection with the Krakatoa outburst was pointed out. Mr. Ascroft made his drawings on the bank of the Thames, a little west of London, on the evening of November 26, 1883. They represented the grand general colouring of the western sky from shortly after sunset (3h. 57m. p.m.) to the final dying out of the afterglow at about 5.15 p.m.

IN the September issue of *Man*, Mr. W. N. Beaver discusses the eating of human flesh in the western division of Papua. A long experience of almost every district of British Papua inclines him to believe that while ritual or ceremonial does in many cases form the prime reason for cannibalism, in by far the greater number of cases human flesh is eaten because it is a food and is liked. The practice, however, is not habitual, but sporadic. It is said that snake-eaters are always cannibals. This is not a certain fact in Papua, but it is certainly a coincidence that the majority of snake-eating tribes in the island are also cannibal.

IN *Man* for September Mr. J. P. Johnson describes a collection of pygmy implements from Western Australia in the Perth Museum, and others from Eastern Australia in the Sydney Museum. Like those from South Africa, he regards them as merely diminutive forms or varieties of what French archæologists term the Audi, Chatelperron, and Gravette *pointes* or *couteaux*. These are characteristic of the Aurignaco-Magdalenien specimens of north-western Europe where the crescent is absent, and are prominent in the Capsian specimen of Sicily where the crescent is present. In Australia, however, they do not appear to be associated with scrapers as in Europe and South Africa.

ABOUT 1830 some Chinese and Malay convicts confined in the jail at Mahableshwar, the chief hill station of the Bombay Presidency, are supposed to have introduced the cultivation of the strawberry, which has now become a flourishing industry. The attempt to introduce plants from Saharanpur failed, and the present stock was obtained from Bangalore, where its previous history is unknown. Though they are good and command a ready sale, the berries are capable of much improvement. Dr. W. Burns, economic botanist to the Government of Bombay, who gives a valuable account of the industry in vol. ix., part iii., of the official Agricultural Journal of India, believes that if new stock can be introduced from Europe and America, there is hope of the production of high-class fruit in large quantities in the Yenna Valley.

IT is satisfactory to observe that many field clubs and local natural history societies are devoting attention to the preparation of a flora of the districts in which they operate. The Leicester Literary and Philosophical Society, in its Transactions, vol. xviii., for 1914, recently published, describes the work that is being carried on by their initiative. Many important discoveries, such as *Ceratophyllum submersum*, *Rumex pulcher*, besides cryptogams, have been made. Negotiations with the Uppingham and Rutland Natural History Societies have resulted in an arrangement to include Rutland in the Leicestershire work. So far as the original survey on ecological lines is concerned, the general editor has now defined the main lines of vegetation, and has recorded them on the 6-in. maps. An appeal for assistance from local workers has met with active support.

IN the notice of the recovery of the type specimen of *Pliolophus vulpiceps* in our issue of September 17 it should have been stated that Messrs. Flower and Garson (Cat. Osteol. Mus., R. Coll. Surgeons, part ii., p. 380, 1884) were the first to suggest the identity of Pliolophus with Hyracotherium.

ACCORDING to an article contributed to a Maltese journal of July 23 by Mr. G. Despott, of the Natural History Museum, Malta, the cetacean alluded to in

NATURE of August 13 (p. 620) as having been stranded at Birzebbugia on July 20, is undoubtedly, as suggested in that note, a blackfish (*Globicephala melaena*). The identification is confirmed by photographs forwarded by Mr. Despott, who states that this specimen is the first record of the species in the Mediterranean.

FROM the report for 1913, contained in vol. iv., No. 8, of its journal, we learn that the East Africa and Uganda Natural History Society continues to maintain its record of progress and prosperity, the number of new members being greater than in any previous year. His Excellency Sir H. C. Belfield has been pleased to collect a fund which is to go towards the establishment of a permanent museum, with a curator, and a plot of ground in a central position in Nairobi has been reserved as a site for the proposed new buildings. A feature of the aforesaid number of the society's journal is a coloured plate of the African brown-bellied kingfisher (*Halcyon semicoeruleus*), illustrating an article on this strikingly coloured species by Dr. V. G. L. van Someren.

IN concluding his article on pattern-development in mammals and birds in the September issue of the *American Naturalist*, Dr. G. M. Allen discusses partial albinism in wild birds, and what is termed "centrifugal coloration" in both groups. In the former section it is suggested that the white eyebrow-stripe in the so-called ringed guillemot—now known to be a special phase of the ordinary *Uria troile*—represents an incipient albinism forming a line of demarcation between the dark ear-patches and crown-patches. The author would expect to find this white in young birds, and suggests that, if of a recessive nature, it may eventually be developed in a much larger number of members of the species than is at present the case. As regards centrifugal coloration, this is the development of black pigment at the extremities or points of the body, as exemplified by the black nose and tail-tip not infrequently seen in domesticated cats. The so-called Himalayan rabbits, in which the whole animal is white, with the exception of the black nose, ear-tips, and toes, form another striking example. The paper winds up with a summary of the author's views.

IN connection with the military operations of our Japanese allies in the province of Shantung, the meteorological observations made in Korea, on the opposite shores of the Yellow Sea, for about ten years, are of especial interest. We have recently received the results for the year 1912, and for the lustrum 1906–10. The following extracts from these valuable data, refer to stations in the north-west and south-west of Korea for the lustrum in question. *Chemulpo*: Highest mean monthly maximum temperature (August), 82·8°; lowest mean monthly minimum (February), 19·6°; annual rainfall, 31 in., on ninety-seven days; sunshine, 2726 hours (61 per cent. of possible amount). *Mokpo*: Temperature as above, 86·4° (August); 27·9° (February); rainfall, 38·3 in., on 126 days; approximate sunshine, 2310 hours (52 per cent. of possible amount). The instruments and method of observation are of the same excellent character as those at meteorological stations in Japan, and the tables are carefully prepared by Mr. Y. Wada, director of the observatory at Chemulpo.

WE are glad to see from *Symons's Meteorological Magazine* for September that Dr. Mill is able to resume the editorship after an interval of nearly a year. The size of the magazine has had to be somewhat reduced, owing to the fall in the income of the British Rainfall Organisation through the war. This number contains an interesting article by Mr. H. H. Clayton and Mr. W. M. Hays, entitled "Arguments for Basal and Immediate Crop Estimates," the gist of which is the possibility of substituting for present estimates of crop conditions, based on reports by growers and bureau agents, opinions based on climatic records supplied by a World Meteorological Organisation from daily weather telegrams. The publication by the U.S. Weather Bureau of daily weather charts for the northern hemisphere, and the collection and publication of data from stations to represent the meteorology of the globe, by the efforts of the Solar Commission of the International Meteorological Committee and of the Meteorological Office, are great steps in the above direction. But, as we have before had occasion to point out, the proposals made to the meteorological conferences and meetings to promote the establishment of an international weather bureau have not met with any definite encouragement.

IN the Bulletin of the American Mathematical Society, vol. xx., p. 10 (July), Prof. Edward Kasner discusses certain exceptions to the general rule according to which the ratio of the arc to the chord of a curve tends to the limit unity. In the case of an ordinary singular point the ratio may, of course, be indeterminate, but the author finds that in the case of certain imaginary curves the ratio may have a definite limit different from unity at some particular point or points, even if the curve be analytic in the neighbourhood of the point or points in question. The most typical case is that of a plane curve at a point where the tangent passes through one of the imaginary circular points at infinity. At such a point the ratio of chord to arc becomes $\frac{2}{3}\sqrt{2}$, $\frac{2}{4}\sqrt{3}$, $\frac{2}{5}\sqrt{4}$, and so on according to the order of contact with this particular tangent. The discrepancies are due to the fact that the elements of chord and arc from the point to a neighbouring point both vanish to the first order of small quantities.

IN the Proceedings of the Physical Society for August (vol. xxvi., part 5) Dr. Lees discusses the connection between Fourier's series and the method of least squares. This connection was pointed out in Tait's "Natural Philosophy" without proof, and we believe that several other writers have dealt with the question in greater or lesser detail, possibly covering the same ground. The present paper contains a brief proof of the proposition that if it is required to obtain a finite trigonometric series having given values for a corresponding finite number of values of the argument, the series obtained by the Fourier expansion makes the sum of the squares of the errors a minimum.

It was in 1871 that Lord Rayleigh first proposed a theory to account for the scattering of light by small particles, and in particular to explain the blue sky. Various other papers have followed on the subject by different writers. In the *Bulletin de l'Académie des Sciences de Cracovie*, Dr. Ladislas Natanson, in a paper communicated last January, discusses the problem on lines consistent with the modern electron theories. The author first considers the effect of a vibrating electron in the presence of a train of electromagnetic waves, using Planck's formula. An expression is found for the energy of the scattered wave; this is found to vanish in the direction of propagation and to be a maximum in the equatorial plane. The electric and magnetic energies are not in general equal. When it is sought to deal with a medium containing a large number of such vibrators the problem cannot be solved without making certain assumptions which can only be regarded as a first approximation. With these the author obtains formulæ for the coefficient of transmission of the medium and its dependence on the wave-length.

The scientific study of the acoustical properties of public buildings is a subject the neglect of which may involve losses of thousands of pounds. The large hall presented to the University College of North Wales by Sir John Prichard-Jones possesses an echo quite equalling the famous one of the baptistery at Pisa, but this feature renders it useless for many purposes for which it would otherwise be in requisition. Mr. F. R. Watson's article on the acoustics of auditoriums in the University of Illinois Bulletin xi., 29 (Bulletin No. 7, Engineering Experiment Station; London: Chapman and Hall, 1914, price 20 cents) is a welcome contribution to this study. The investigation refers primarily to the auditorium of the Illinois University, which has formed the subject of the author's researches since 1908, one year having been spent by him in general study abroad. Mr. Watson discusses Sabine's formulæ for the effect of absorption on reverberation, and arrives at the following general inferences:—Wires have but little effect; air currents due to ventilation may even be worse than useless. In his survey of the building in question he has determined both experimentally and theoretically the paths of the sound waves reflected from the various surfaces, plane and curved, of the building, and the formation of foci; and a remedy has been proposed involving the placing of curtains in positions determined from these observations. The sources of sound employed in these experiments include a ticking watch, an alternating arc current in presence of a concave mirror, and a directed source ingeniously obtained with the aid of a metronome. But the Illinois auditorium with its concave walls and curved roofs is so different from the rectangular Prichard-Jones Hall at Bangor, that an investigation which is sufficient for one building will scarcely be likely to explain, except very partially, the defects of the other.

It is remarkable that no extended use has ever been made of a phonographic attachment to a telephone for recording spoken messages. The Poulsen telegraphone in which the received currents produced a record by magnetising a steel wire or tape was undoubtedly a scientific success, and perfect speech reproduction could be obtained by its means, but it never made a position for itself as a commercial instrument. The reason for this may have been that the telegraphone had to be electrically connected to the line, and there were possibly some technical or administrative objections to such an addition to a subscriber's instrument. From an article in the *Scientific American* it appears that a new Edison instrument, called the "telescribe," has recently been evolved in which the arrangements are more akin to the Edison wax phonograph. The ordinary telephone receiver of the subscriber's instrument is placed against a very sensitive transmitter, in a local circuit with a battery and another "special" telephone receiver, and the latter is arranged to emit its sound waves against the ordinary sound-recording diaphragm of a phonograph. The instruments of this local circuit must apparently be designed so as to act as a telephone relay and increase the amplitude of the vibrations sufficiently to cut the wax phonograph cylinder. A second receiver on the subscriber's set enables him to listen to the message, and even to contribute his share of the conversation, so that the whole or part of it may be recorded as he desires. This is certainly an ideal arrangement if it gives satisfactory records without impairing the clearness of the articulation by the relaying process.

The value of the scientific exploration of the agricultural products of India is well illustrated in a paper by Mr. C. Somers Taylor, agricultural chemist to the Government of the province of Behar and Orissa, contributed to vol. ix., part iii., of the official Agricultural Journal of India. Discussing the problem of the varying amount of sugar obtainable from cane juice, he remarks that at one time this was thought to be dependent on the presence of glucose. This theory has now been proved to be unsound by the great Dutch sugar chemist, Geerligs. On the other hand, the same authority—and his conclusions are verified by Indian research—shows that a high percentage of potash is, as a rule, accompanied by a low quotient of purity, a low saccharine content, and a high glucose content when the cane is ripe. The question of potash content is carefully examined by Mr. Somers Taylor in this paper, and he concludes that work on the potash content of cane juice is likely to be of great value in the examination of different varieties of canes, and in consequence the official chemists propose to take up this study more fully in the near future.

The Institute of Chemistry has issued a "History of the Institute, 1877–1914," compiled, by direction of the council, by Mr. Richard B. Pilcher, the registrar and secretary. The institute had its origin in a meeting held on April 27, 1876, to discuss the necessity for organisation among chemists for the purpose of enhancing their professional status; at this meeting Prof. (later Sir) Frederick Abel presided. A committee was appointed to confer with the Chemical Society with regard to a scheme for establishing an organisation of professional chemists, and ultimately it was decided to form a new association, and the first officers of the council, with Prof. Frankland as president, were elected in 1877. The membership, which in February, 1878, was 225, had grown in March, 1914, to 1454. Recently new buildings have been erected, duly equipped, and suitable for the purposes of the institute, at a cost of 17,080*l*. Owing to the dispute in the building trades in the early part of this year, these new buildings have not been completed, so that the institute will occupy their present premises at 30 Bloomsbury Square, if necessary until Christmas. A special council meeting was held on June 12 to consider the question of bringing the work of the institute more prominently before the public. Four lectures will be given during the winter months.

OUR ASTRONOMICAL COLUMN.

Comet 1913*f* (Delavan).—Delavan's comet is becoming a less favourable object for evening observation owing to the diminution of its declination and its movement westward among the stars. It attains, however, a considerable altitude in the hours just before dawn, and this is the best time for observation. It is situated not far from the star χ Ursæ Majoris, and is approaching α Can. Venaticorum. On clear evenings it is a conspicuous object near the northern horizon and its tail has increased considerably in length. The series of fine nights recently experienced has given opportunities for a considerable amount of observation.

The Recent Solar Eclipse.—The recent eclipse was observed at Paris and Algiers, though at both stations it was only partial. At the Observatory of Paris MM. Bigourdan, Boquet, Chatelu, and Le Morvan made the observations, while M. Gounessiat worked under good conditions at Algiers. The results of these observations have been communicated to the *Comptes rendus*, August 24 and 31. In the case of Paris, M. Bigourdan determined the observed minus calculated times of commencement and end as −23 sec. and −38 sec. respectively. M. Gounessiat, from his observations at Algiers, gives the corrections to his observed times of first and last contact as −25 sec. and −38 sec. respectively.

French Provincial Observatories in 1913.—The pamphlet published by the French Minister of Public Instruction and Fine Arts, entitled "Enquêtes et Documents relatifs à d'enseignement supérieur," vol. cix., contains the reports of the French provincial observatories for the year 1913. The observatories dealt with are Algiers, Besançon, Bordeaux, Lyons, Marseilles, Nice, Pic du Midi, and Toulouse. The volume gives a good idea of the various branches of astronomical and meteorological work, which forms the main routine work of the several institutions, besides stating the actual progress made during the past year. It gives further lists of the various staffs, showing that each observatory employs from six to nine scientific members, excluding the Pic du Midi, which is composed of four

Strong Magnetic Fields for Solar Research.—MM. Deslandres and Perot present, in the *Comptes rendus* for August 24 (vol clix., No. 8), the second of their series of experiments for the production of most intense magnetic fields. This work is particularly important in its bearing on experiments relative to researches on solar magnetic fields. It is pointed out that the progress of advance in the construction of electromagnets is to be found, not in the saturation of large masses of iron, but in the judicious use of intense electric currents. The authors of the above paper do not therefore advocate the exceedingly ponderous apparatus of Weiss, which weighs about 100 tons, but are directing their attention to comparatively small and light electromagnets. In the present paper they describe somewhat in detail the methods they adopt and the success already achieved speaks well for further advance. With the support of the Princess of Polignac, the electric supply company of Paris, and the electric station of the Bon Marché, they have been able to test their new method of water cooling of the magnetising coils, and have without the use of iron reached a field of 50,000 gauss as measured by its effect on one of the zinc lines. They use thin silver tape instead of wire in their coils, and cool it by a stream of water flowing across instead of along the tape. The difference of potential between two consecutive turns of the tape is kept below 1·4 volts in order to minimise electrolysis. By the use of iron cores the authors hope to be able eventually to reach fields of 150,000 gauss, but their work has been interrupted by the war.

RECENT ECONOMIC ZOOLOGY.

THE University of California has recently issued (Publications in Zoology, vol. xi., No. 14, 1914) a monumental paper on economic ornithology by Mr. H. C. Bryant; although a single species only—the Western Meadow-lark (*Sturnella neglecta*)—is dealt with, the memoir extends to 133 pages, with four plates and many statistical tables. All modes of investigation—field work, experiments with captive birds, examination of stomach contents of adults throughout the year and of nestlings, summaries of the influence of season, locality, age and sex, on the nature of the food—have been brought to bear on the problem. The farmers of California, in reply to circulars sent out by the author, were about equally divided in opinion as to whether this particular bird is harmful or not. Mr. Bryant comes to the conclusion that except for a reprehensible habit of destroying sprouting grain in spring, the Western Meadow-lark must be regarded as beneficial from the numbers of harmful insects and weed-seeds that it devours. In addition to the economic interest of this paper, a discussion of the value of "protective" adaptations in insects appeals to the naturalist. A large proportion of the stomachs examined contained hairy caterpillars, ants, wasps, and bees, as well as "cryptically" coloured grasshoppers and weevils. The author admits, however, that the factors of situation and motion at the time of capture might explain why the form and hue of these latter failed to protect them.

The last published part of the Bulletin of Entomological Research (vol. v., part 1, April, 1914) contains an interesting account of the Gold Coast by Dr. J. J. Simpson, who has paid special attention to tsetse-flies and other blood-sucking insects. Mr. W. W. Froggatt has a short but valuable note on sheep-maggot flies in Australia, where species of bluebottle (Calliphora) have, during the last ten years, acquired the habit of "blowing" healthy sheep, as the greenbottle, *Lucilia sericata*, has long done in this country. A minute chalcid parasite does something to keep the flies in check, but they are said to have caused the loss of a million pounds to stockowners last year in New South Wales alone. *Glossina morsitans* in Nyasaland is discussed by Dr. J. O. Shircore, who has traced the fly to four "primary centres," where extermination might be attempted with some chance of success.

Besides the bulletin, the *Review of Applied Entomology* continues to be issued by our Imperial Bureau. The summaries of papers from all parts of the world are of great value to workers, who will doubtless be especially grateful to have the essence of much important Russian literature—otherwise unavailable—brought within their reach.

The twenty-first report of the Danish Biological Station to the Board of Agriculture (Copenhagen, 1914) consists of an important memoir by Dr. C. J. G. Petersen on the animal communities of the sea-bottom and their importance for marine zoogeography. By means of a new "bottom-sampler" the whole animal population of a square metre of the area under investigation can be brought up in one haul, and the results of numerous "valuations" of the sea-bottom at two hundred stations in the North Sea and the Skagerrak are set forth in statistical tables and photographs, the latter reduced to scale, giving a vivid impression of the density of the population and the relative abundance of its various members. By this method of research, Dr. Petersen treats the marine fauna as botanists of the ecological school treat the vegetation of an area, and defines an "Echinocardium-Venus" or a "Brissopsis-Turritella" community as characteristic of certain regions. In the use of this method the author believes that "the animals which are not seasonal and which compose an important part of the whole mass of the community owing to number or weight, will presumably be best suited for characterising the community, and must also be considered as giving a good idea of the outer conditions on which the community is dependent." G. H. C.

FATIGUE STRESSES.

SINCE Wöhler published in 1871 the results of his tests on the behaviour of steel under repeated stresses a great deal of work has been done in this direction. The experiments of Stanton, Eden, Rose, and Cunningham are well known in this country. The subject is a difficult one, and is complicated by the lack of any satisfactory correlation between the tests. Further, experiments on repeated and alternating stresses take a long time to carry out.

In his memorandum to the Manchester Steam Users' Association, Mr. C. E. Stromeyer gives account of some interesting experiments. Mr. Stromeyer has found that all his tests could be harmonised by arranging for successive fatigue fractures on the same test piece, 1 in. or 1½ in. apart. From these tests an empirical relationship was derived, and found to be applicable not only to bending fatigue tests, but also to push-and-pull, and to torsion fatigue tests. The empirical formula is $N = 10^6C^4 \div (S_n - Fl)^4$, in which $\pm S_n$ is the nominal fatigue stresses to which a sample is subjected, Fl is the fatigue limit of the material, C is a constant for the given material, and N is the number of repetitions of the stress S_n, which the material will stand before it fractures. The close agreement of this formula with the test results is demonstrated by diagrams given in the memorandum.

An idea for determining the fatigue properties by means of a single test suggested itself, and proved to be so practical that a new machine has now been constructed for the association with which fatigue tests on the improved lines will shortly be undertaken, both as regards push-and-pull stresses, bending stresses, and torsion or shearing stresses. In principle, the new test consists in determining the stress at which the temperature of the test piece begins to rise in consequence of internal friction. There is practically no internal friction in steel up to a certain limit of stress, and hence no heat would be developed in an alternating or repeated stress test within this limit of stress. The test piece was surrounded with a loose sleeve of thick india-rubber, and circulating water passed along the annular space between the test piece and the rubber; delicate thermometers were used to measure the difference in temperature of the inlet and outlet circulating water. At low stresses no difference in temperature was noticed; when a difference of about 0·01° C. was noticed the fatigue limit was supposed to have been reached, but the fatigue stresses were increased slightly in order to confirm this indication. A considerable difference in temperature was now apparent, but would generally disappear again if the alternating stresses were reduced below the limit. These calorimetrically determined fatigue limits were generally defined very clearly, and may be depended upon as being nearly correct.

Further, the calorimetric fatigue limits agree remarkably well with the fatigue limits Fl found by extrapolation of series of tests carried to the point of fracture. Hence it is possible to shorten fatigue testing from several weeks' or months' duration to one or two hours. A single test piece is prepared—duplicates, of course, are desirable—and submitted to gradually increased fatigue stresses until the fatigue limit Fl is found calorimetrically; then the stresses are increased until a large quantity of heat is evolved, and the alternations of stress are counted up to fracture. These tests fix both Fl and also the coefficient C.

The method seems very promising, and may lead to a simple workshop fatigue test of considerable practical value being adopted in many works where the time occupied in alternating stress tests has hitherto been a barrier.

THE ROYAL SOCIETY OF NAPLES.[1]

THE *Atti* and *Rendiconti* of the Royal Society of Naples for the past year show what valuable work is being done by this Society. The *Atti* (corresponding to our Transactions) contain sixteen memoirs, occupying more than five hundred quarto pages. Papers of less importance are inserted in the *Rendiconti*, which correspond to our Proceedings. Attention should be directed to the very useful and extensive bibliographies which accompany several of the memoirs.

While all the principal sciences are represented, it is to the domain of pure mathematics that the more important work belongs. Mr. G. Gallucci contributes a valuable memoir on configurations (*Atti*, No. 4); Mr. D. Montesano, others on the Cremonian groups of numbers and the bilinear complexes of conics in space (Nos. 7 and 8); Prof. E. Pascal describes integraphs for differential equations (No. 16), and for the graphical solution of integral equations; Mr. G. Andreoli explains a method of determining superior limits to the moduli of the complex roots of a given algebraic equation. In the *Atti* (No. 10) Mr. R. Giacomelli gives a biographical notice of Giuseppe Ballo, a contemporary of Galileo. Among other papers may be mentioned those of E. Guerrieri on the light-curve of Mira Ceti, drawn from numerous observations made during the years 1902–13, of Dr. M. Fidele on the innervation of the reptilian and batrachian heart (*Atti*, No. 2), and of F. Zambonini on Vesuvian mineralogy (No. 12).

The condition of Vesuvius since the eruption of 1906 is the subject of several interesting papers. Prof. G. Mercalli, whose death last March deprived us of an unwearied investigator of Vesuvian phenomena, contributed two notes in July, 1913, on recent changes in the crater which, in his opinion, point to an early revival of activity after seven years' rest. Mr. O. De Fiore, in a memoir on the period of repose in Vesuvius which began in 1906 (*Atti*, No. 14), remarks that the great outbursts attract most attention, but urges that the intervening periods of repose are also deserving of study, for it is through their investigation that we may be led to foresee a coming revival of activity. He distinguishes three principal, though overlapping, phases in the Vesuvian period of repose, to the first of which—the degradation of recent forms—the present memoir is devoted. Lastly Dr. A. Malladra, of the Vesuvian observatory, describes the solfatara of the Atrio del Cavallo, which separates the modern cone of the volcano from the cliffs of Monte Somma.

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[1] "Atti della Reale Accademia delle Scienze Fisiche e Matematiche (Società Reale di Napoli)," vol. xv, 1914; Rendiconto, vols. xix, xx, June, 1913—June, 1914.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY PROF. JOHN PERRY, D.SC., LL.D., F.R.S., PRESIDENT OF THE SECTION.

I WISH to make some general remarks upon the science of education. As in the chapter which was entitled "The Snakes of Iceland," and which merely consisted of the sentence, "There are no snakes in Iceland," I might finish this Address at once by saying "There is no science of education." There is the art or practice of teaching or pedagogy, just as there used to be the art of engineering. It was only slowly that the subject of Section G, the Science of Engineering, was created; but the subject of Section L, this section, has still to be created. In the creation of a science we first and for long periods have the observation of detached phenomena and disputes about them, because the phenomena seem complex, having no obvious connection with one another; then experiments simplify things, and gradually the science is created by inductive reasoning and research. In education, observation and disputes have occupied much time, and we cannot say that the phenomena have become much simplified by such experiments as have been made. Every man in the street considers that his opinions on education are as good as those of anybody else. I suppose that almost nobody would refuse to make an after-dinner speech on any kind of education, whereas he would not dream of speaking about geometry, or chemistry, or physics, or physiology unless he had studied these subjects. Any ordinary citizen thinks himself fit to be a member of the governing body of a school or college, and the disasters due to this belief are worse than what would occur if we gave to such men the command of ships. The ordinary man, especially the Parliamentary man, who thinks that the members of a committee on some scientific business ought all to be non-scientific men, will jeer at this statement, but it is, nevertheless, fatally true.

It is possible that, even if we had the science, the pedagogues would pay no attention to its principles, just as there are industrial chemists in London whose businesses are dwindling because they pay no attention to the science of chemistry. Pedagogy is in a worse condition than industrial chemistry, because chemical products can be easily tested as good or bad, whereas the pedagogic product is exceedingly difficult to test. The customer is the worst of judges. Those soul-destroying cheap schools described by Mr. Wells used to be very numerous; they are still, many of them, in existence. Every observant person knows of these places, to which small shopkeepers still send their sons, because they are genteel and cheap, and because Latin is taught, and perhaps French. Did any such parent ever object to the result of the schooling? Even when a boy has become a man, neither he nor his father knows whether his defects or merits are due to bad or good schooling. Please read Mr. Wells's book about Mr. Polly. Again, the reforms in pedagogy which, with Dr. Armstrong, I have been clamouring for during the last thirty years, would cause the best-known pedagogues to scrap all their machinery, and so to lose nearly the whole of their invested capital. Even when they are not influenced by the idea of losing money, these men cannot be made to believe in the necessity for reform any more than the Central African worshippers of hideous idols can be converted, for with just as much intensity do they worship the product of our present schools and colleges. The pedagogue is not alone in his false worship; this is the day of small men, common-place men, men manufactured like so many buttons, so that it is almost impossible for a great man to appear; everybody is compelled by custom or by law to go to school, and the school ideal is just as false and mean and material as any false religion ever was. Every clever man who has gone to a public school and to Oxford or Cambridge worships the system which has taken from him his spiritual birthright, his individuality, his initiative, his originality, his common-sense, his power to think for himself—yes, and I may say his belief in himself. He has become too much like a sheep, ready to follow the bell-wether; he is a man who has greatly lost his soul. Average boys leaving a public school all speak in the same way, in the same words, about anything. They are nearly as much alike as things manufactured by the same machine. An expert easily tells from what school a boy has come, because there is nothing left in his mind which is not common to the whole school.

The education given in England to boys until they leave school at twenty, and until they graduate at a university, is almost altogether classical: that is, founded on the language and literature of Greece and Rome. On the day on which I wrote this there was a report of an address in the *Times* which said that this study was the cause "of all imaginative aspirations, of all intellectual interests"; "it enabled men to appreciate not only Homer and Virgil, but equally Dante and Milton, Goethe, and Wordsworth, all the great thoughts of all ages and all lands, and to be awake to the movements of their own day." It said that this study made a man "a better man of business, a better lawyer, a better merchant, a better stockbroker, a less hidebound politician." "Those who would banish Greek or would make it the peculiar property of a select few, did a grave disservice to the whole cause of intellectual and spiritual life." The writer then described his own diligent reading in the train every morning; in the course of a few months he had read the "Iliad," the "Odyssey," the "Aeneid," five books of Livy, and the whole of "Catullus" and "Martial." It seems almost as if he must have all extant classical literature off by heart. He must have enormous satisfaction as he sits in the train looking at the quite common travellers who are reading about the affairs of the nation in English newspapers. I quote the above statements because they are typical. All our classical friends say that sort of thing. But I do not pay much attention to them, because I know that the greatest classical scholars only devote themselves to editing some Greek text that has been edited over and over again. These men rave about the glory of youth and beauty as preached by the Greeks, but their enthusiasm is not shown in any practical way. We must believe that this enthusiasm exists, because these men tell us themselves that they experience it. But what is a fair man to say when he hears his friends talk of the beauties of Sophocles and Euripides if he knows that these friends never read Shakespeare or Jane Austen, or Goldsmith, or Dickens? I have not referred to the fact that classical scholarship leads to power and wealth in the Church and State, to palaces and baronies, to purple and fine linen. Leaving such things out of account, I have a suspicion that this worship of classics is like one's fondness for the rhymes, often rubbishy rhymes, that associate themselves with our infancy and boyhood, or like Johnson's belief that his wife was amiable and beautiful. It is even possible that the very best scholar is of but little use to the world. It would be easy to show that, since the sixteenth century, the classical pedant has done little but spoil the rich English language of our Bible. We want now a man like Bishop Pecock to delatinise our language.

Let us, however, consider a boy of another class—the boy called clever, say, one in twenty of the whole. At the age of twenty or twenty-one, stale and tired with the reception of ancient learning, of other men's thoughts, he gains a fine scholarship at the university, where he is supposed to be almost a free man, and all the use he can make of his freedom is to go on absorbing ancient learning, keeping his nose to the grindstone as if he were still a schoolboy. Treated as a boy from seventeen to twenty-one, he remains a boy till he is twenty-four, and he cannot help becoming a small-minded, though clever and learned, man, who fails to see that literature is no longer the possession of a small class. Yet if he had left school for the university at sixteen or seventeen, we might hope that university freedom and association with others and with learned men might have made him great, a great poet, a man of cultivated imagination, fit to become a great writer, a great philosopher, a great politician, a ruler of men. One of the curses of intellectual England is due to schoolmasters keeping men at school and treating them as boys to the age of twenty or twenty-one. They take scholarships as stall-fed cattle take prizes at agricultural shows.

Our famous writers had, like Burns, no school education, or else only a short school education. Boys went to the university too early after the Renaissance, and Bacon entered Cambridge at the age of thirteen. Shakespeare, thank God, was only at a grammar school, and is supposed not to have completed even that short course of school work. Even Ben Jonson, who was so proud of his learning and rather scorned Shakespeare for his "small Latin and less Greek," had only a short school education. Phineas Fletcher went to Cambridge at sixteen. Massinger went to Oxford at eighteen. Of the school time of some of our most original writers we have but little information, but that it must have been short we have indirect proof. Beaumont's first play was produced at the age of twenty-one. Waller entered Parliament and wrote his first poem at eighteen. Dryden went to Oxford at seventeen. Milton went to Cambridge at seventeen. Addison went to Oxford at fifteen. The whole of Pope's school education was four-and-a-half years. Swift went to Dublin University at fifteen. Goldsmith, after a most erratic school time, entered Dublin when he was fifteen. Our present school system is to keep a boy with his nose to the classics grindstone from the age of eleven to the age of twenty, and copies the German system. The result is the same in Germany and England. Genius is very common in both countries, but 99 per cent. of it is destroyed by the schools. It is, however, when we come to study the average boy—nineteen in twenty of all boys—that the system looks most devilish. In Germany it is worse than in England. There even the average boy submits, and plods hard all the time, because there is a great reward for him—a diminution in his time of military service. Well, the result for the average German boy is that he becomes stupefied, dull, and loses all initiative. The average English boy gets much less of these evil effects, because he neglects his schoolroom work and keeps his mind active and his soul alive by means of football and cricket. It is from this great characteristic, that knowledge and wisdom come from doing, and not from abstract reasoning, that the British race rules the world. We learn all that induces common-sense from observation and experiment. I often used to observe that a boy whose face was attractive because of its brightness and intelligence in the cricket field, seemed when he entered my classroom as if an isolating veil of unintelligence suddenly covered his face. He had settled for life that he could not understand the classroom work, and he refused to make any more efforts. Even the clever boy's soul is to some extent protected by his sports, so that in every way less harm is done in England than in Germany. Still, the system produces, even from clever boys, only clever, dull men, fit to be barnacles in the public services. The system may be said to give a good training for lawyers—the necessary clever kind of lawyer of the Law Courts and Chambers who is mute in the House of Commons.[1] But it destroys the higher qualities of men and makes them narrow. It ought to be remembered that Lord Somers was the only great lawyer who was also a great man. Poor boys cannot get this training unless they are so unlucky as to get scholarships, or are induced to attend university extension lectures; and it results that nearly all our best writers, writers with imagination and originality and initiative and individuality, have been boys of the common people. Although poor boys are most frightfully handicapped for the race to distinction, I do not think that the poor child is much handicapped by mere heredity, for he is naturally nearly equal to a boy of the highest lineage. Natural selection up to the time of the first great civilisations, when there were comfortable houses and palaces—say, 100,000 years ago—together with the effects since then of revolutions and wars of conquest, involving slavery of the conquered, have created a wonderful equality among the individuals of mixable races.

For the average boy at a public school the school work is a terrible uphill grind all the time; a soul-destroying, stupefying business, so stupefying that he makes no complaint, he merely suffers. He feels that he is a failure, learning nothing that can be of spiritual or material value to him in his future life. Of course, he can pass examinations; anybody can be crammed to pass an examination, but after the examination he forgets what he was supposed to have learnt.

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[1] The acuteness of a lawyer in finding the meaning of a document is very wonderful. Almost any mental power can be cultivated to such a very high degree that it almost seems diabolical. A trained person after passing a shop window rapidly is able to describe every object in the window, although the objects may be very numerous and curiously different. Yet this same man may not be at all clever in other ways. In patent cases a clever judge takes in the most elementary scientific knowledge with very great difficulty. The readers of the hundreds of newspaper articles of any morning—as like one another as herrings—are awed with their display of culture, of depth of thought, of knowledge, and with, what is more astounding than anything else, an infinitely perfect Oxford polish. Watching the performances of an Oxford man of letters is like watching a good billiard player or a skilled musician. His mind is filled with the thoughts of other men, pigeonholed ready for use. It is extraordinary that a man can have been so educated as to be a good debater, to be able to make a fine speech, that he may have taken a degree at Oxford, that he may have passed examinations in classics, philosophy, and mathematics, and yet be exceedingly ignorant, illogical, and unscientific.

The present system of education is to be condemned for other reasons. It is exasperating that all the most important, the most brilliant, the most expensively educated people in England, our poets and novelists, our legislators and lawyers, our soldiers and sailors, our great manufacturers and merchants, our clergymen and schoolmasters, are quite ignorant of natural science; and it may almost be said that in spite of these clever ignorant men, and men like them in other countries, through the agency of scientific men, all the conditions of civilisation are being transformed. I do not think that a fact of this kind would have been neglected by the philosophers of Greece (who scorned to know any other language than their own) or the learned men of Rome, but when some of us direct attention to it and its neglect by modern philosophers we are sneered at as Philistines. It is a curious kind of culture which scorns the lessons of history, the study of man in his relation to nature, the study of the enormous new forces which are now affecting the relations of nations to one another. How many of our rulers know the astounding fact that the cost of the most unskilled work done by man costs 1000 times as much as when that work is done by a steam-engine? Hence it is that the steam-engine has given means for leisure and high culture, yes, and low culture and decadence, to hundreds of people instead of units. And the steam engine enables rulers to spend 100 times as much money on soldiers and sailors and ships and munitions of war as they did 200 years ago.

The university man thinks that he can get some knowledge of science by reading, but without laboratory study he is like the man who said "barley" when he wanted to escape from the robbers' cave and ought to have said "sesame." Do you know the ballad about Count Arnaldos, who envied the old helmsman his weird and wondrous powers?

"Would'st thou," thus the helmsman answered,
"Learn the secret of the sea?
Only those that brave its dangers
Comprehend its mystery."

I know that the ordinary university man thinks, like the wistful Count, that he can get all things easily or by mere reading. But, in truth, to read the "Origin of Species," or treatises on astronomy or physics or chemistry, is a misleading performance unless the reader brings to the study that kind of mind which has been developed already by his own observation and experiment.

The university man, ignorant of science, becomes a ruler of our great nation, his duty during war and peace being that of a scientific administrator, and without turning a hair he fraudulently accepts this important duty for which he is utterly unfit. The gods must surely laugh when they see these rulers of ours gibing at scientific things, giving important posts to non-scientific men who scorn and obstruct the scientific men who are under their orders. If Oxford scholars were merely like so many monks in their monastery, living the lives and following the studies which they love, I would say nothing. The revenues so used up are, I think, of no great importance to the country, and busy men elsewhere can only be benefited in knowing that at Oxford and Cambridge there are these lovely lamaseries where men are living in serene air apart from the struggles of the world, living what they think to be the higher kind of life, that of the amateur copying the lives of the scholars of Constantinople before they were so mercifully scattered in 1453, copying the meditative ways of the divines and hermits of the fourth and fifth centuries. Unfortunately the Oxford hermits have by a series of accidents become the rulers of the greatest Empire that the earth has ever seen, and it is very obvious indeed through many other things than the starting of South African wars that they are unfit for their job.

If our rulers were like savage chiefs they might possibly give equal chances to candidates for posts; but unfortunately it is as if our leaders possessed great *negative* knowledge of natural science, and as if a man's chances of being appointed to a scientific post or of having his advice listened to were in inverse proportion to his scientific qualifications. Scientific men look around them and see that everything is wrong in the present arrangements, but they also see that it is useless to give advice which cannot be understood by our rulers. And, indeed, I may say that when by accident a scientific man is appointed on a committee there is a negative inducement for him to do anything.

Many men enter the Services by examination, and it is always through cramming that they pass. In some cases the examination is supposed to be in science. In truth, the scientific habit of thought, the real study of science, the very fitness of a boy for entrance to the service, would unfit him for passing these abominable unscientific examinations. For some army posts, further scientific food is provided by the Government for the classical or modern language or science dummies after they enter the Service. If one wishes to hear how evil this system of pretended education is, let him ask the opinion of some of the professors who are condemned to help in carrying it out. The whole system is foolishness from top to bottom, and the men prepared by the system cannot see how abominable it is, even when they are afterwards trying to improve it; well-mannered mediocrity is everywhere successful and reproduces itself.

I have been dwelling upon the consequences of letting aristocratic university men who are to be rulers of the country have an education which involves no study of natural science. Besides these men we have a larger number of middle-class men who will succeed their fathers in the management, not merely of landed estates, but of much more valuable estates in the manufacture and distribution of things. With them there is the same contempt for books, for learning, and the same absence, not merely of knowledge and of natural science, but of those scientific habits of thought and methods of approaching problems which experimental research tends to produce. These men become the owners of factories the spirit of which ought to be scientific research; the competing factories in Germany, France, and America are run by men of scientific method, but our owners discourage reform in every possible way. The rule of thumb of their fathers and grandfathers is good enough for them. Their factories are so badly arranged that the works cost of any manufacture is twice what it ought to be and the time taken is twice as great. They take eagerly to all sorts of quack remedies for bad trade; they are the easy victims of fraudulent persons. These are the men who discourage all education in the people employed by them, managers, foremen, and workmen. They are what I call unskilled workmen—that is, unskilled owners of works—and it is the university and the whole system of their education which is to blame for their unskilfulness. It is astounding how quickly unskilled owners of works are being eliminated, but there is a new crop of them every year. The want of education of these men is very harmful to the country.

But I get too angry when I think of what our universities might do in the great world of natural science and of the futility of almost all their studies. And this anger is greater when I think that the universities rule the schools. The general higher education of the community is being altogether neglected, the general culture of professional men is being neglected; and in the case of professions involving applications of physical science, useless obligatory subjects are insisted upon, so that for these professions the university is a harmful institution. Medical students have so much hard work in various kinds of grammar subjects required for matriculation that they must be forgiven for their utter ignorance of natural science. But an outside Philistine may also be forgiven when he suggests that the whole country might benefit if the school training of medical students put them more in sympathy with scientific discovery. It is a well-known fact that there are medical men in lucrative practice, said to have the highest university qualifications, who tell you frankly that they do not believe in bacteriology!

A great many young men from the secondary schools are now entering the engineering profession. By engineering I mean any kind of applied physical science. Every important town in Great Britain has established at least one great technical college at large cost in building and apparatus, with staffs of professors and teachers (always badly paid), and it is found that for their first two years the students have to be kept at great cost to the country learning those simple principles of science which they ought to have learnt at school. It is found that they are not only ignorant, but they have none of the habits of thought and scientific method which school laboratory work induces. The clever ones, if they leave school at seventeen, recover from the effects of a school education which prepared men only for being lawyers or clergymen; but the average man finds that he has been prepared only to be a hewer of wood and a drawer of water to the real engineer. It is found in most cases that the successful students are those who have attended primary schools where no boy is compelled to learn any language other than English, and where every boy does laboratory work in mathematics and natural science. There can be no doubt that poor boys have now an enormous advantage over the sons of rich men, for even when the fees of the day classes are large the evening class fees are small, and the poor boys attending the latter are getting to be very fit for higher study in natural science.

The English school system has outlived the medieval conditions which produced it. In old days the only way to knowledge was through Latin: all writing was in Latin. The result then was pretty much what it is now; lawyers, clergymen, and schoolmasters had to know some Latin after school life; the average man forgot anything he had learnt. A few very clever men did read, but the average monk or priest was a very ignorant person.

English people know the worthlessness of the public school system in the mental training of the average boy. Why, then, do they submit to it? However conservative they may be, they would not submit to this worthless system merely because it is hallowed by a history of five hundred years.

The fact is, this worthless system continues because in some occult way it seems to have a connection with something of real importance, *public school form*. There is really no connection. When, in my youth, I was a master at one of the great English public schools, like everybody else, I was a frightful prig in regard to public school *form*. Eton form or Harrow form or Rugby form or Clifton form was the thing at each of these schools which was thought to be of more value than anything else in the world. Dr. Arnold, of Rugby, taught the trick of manufacturing it. It is in itself a splendid thing. The public school boy is trained in self-possession, modesty, cleanliness, truthfulness, and courage. At school his health in body and morals is all-important. He learns to lead and also to obey. But the average resulting man is exceedingly ignorant; he neither reads nor writes, and he has little reasoning power except what his sports have developed. This form is essentially aristocratic. It is based on superiority of position or birth or caste. A man's place is fixed, his attitude to people of higher or lower rank is fixed. He needs no self-assertion, and he cannot become a "bounder," that is, a "cad"; but in Thackeray's sense he is usually a "snob," and in various directions he may be a *prig*. By prig, I mean a man who cannot get outside convention and so cannot exercise his own common sense. One defect is that public school form when combined with poverty cannot make much money by its own ability, and if it does not starve it must join the valets or the grooms. Its strength lies in convention and habit and the belief that poor people are not men but a lower kind of animal who may be pitied as we pity a suffering dog. Such pity can never raise the people or reform abuses. In the Middle Ages young gentlemen of England had the same sort of education. It was probably best in Plantagenet times, when indeed a well-trained young gentleman was not only very healthy and courageous, but he had not much chance of becoming lazy. A man was proud of his heavy armour, and he was trained to act vigorously when carrying it. They were chivalrous to each other, but, alas! to people outside their own class they were cruel. The Black Prince is typical; think of his courtesy to King John of France, and then think of his destruction of the persons and property of all the peasantry in those large regions of France which he covered with his marauding soldiers. This kind of chivalry, which is never exhibited to a lower class than one's own, has its beauty, but it does not suit a democracy; it requires that there should be a lower class than its own. The Spartans needed their helots. The Southern planter in America had fine manners, but he could not have cultivated them if there had been no slaves and mean whites. It is a well-known fact that some years before the Civil War in America it was seriously proposed by prominent Southerners to make slaves of the "mean," that is, the poor whites. The chivalrous Andrew Fletcher of Saltoun showed but little knowledge of his countrymen when he formed his plan for reducing a large part of the working classes of Scotland to slavery. Public school form may sit not unhandsomely upon country gentlemen or any rich men who have many servants or tenants or other dependants, but it does not sit at all well upon poorer men, for it puts them out of sympathy with people among whom they must work. It is heartbreaking when associated with the poverty of a man looking for work in places where he has no influential friends, as it is nearly always associated with illiteracy and want of wisdom, with helplessness and with disinclination to learn. Nobody doubts that a modern country gentleman is much more polished than Squire Western or Squire Lumpkin, but he has much the same opinions and forms them in the same way. The manners of a young officer are certainly superior to those of Ensign Northerton, but he is in much the same state of ignorance. Nineteen out of any twenty young officers, if sent to the top of a hill to observe things, cannot write an account of what they see, and they can hardly describe in spoken words what they see, because their vocabulary is too limited. They cannot write a simple letter in English, although they are supposed to have learnt English in the best way, through Latin. On the day when I wrote the last sentence I happened to see the following statement in the *Times*. It is from an unimpeachable authority, a man whose business it is to teach young officers how to fill up official forms. He was speaking of their ignorance and describing a special instance: ". . . a young officer who shut himself up in a room to write a letter. At the end of two hours he was found sitting, very pale, before a large sheet of paper, on which he had written, 'I say Cox'—'Cox' being the name of the regimental banker." He did not know even how to begin to write a letter.[2]

We ask the schools for mental power as of old one asked for bread, and they give us a stone. No doubt public school form is a beautiful stone, a diamond; but we want some bread as well, even if it were only in the Falstaffian proportion of bread to sack. For my part I do not see why the average boy at school should not have reasoning power and a love for reading and knowledge as well as good manners, and this is why I ask for a great reform in our schools. We want from the school what nature has not been accustomed to give, and what home life cannot give, the development of the intellect, and the school fails to give it in ninety-five out of every hundred cases. The great danger in school life is that it may hurt individuality, originality, because a boy, however harum-scarum, is naturally conventional and imitative. Good form comes easily, therefore, and the master is more than satisfied, he is proud. He often speaks of it as *character*, but he is quite wrong. Character comes from home life, not from school life, which indeed is rather antagonistic to character. It comes from contact with fathers and mothers, brothers and sisters, relations and friends. School life tends to induce a contempt for the lower classes and a slavish admiration of the upper classes, which is altogether wrong in a democracy, and can only lead to evil.

It always happens that the real education of the average man begins when he falls in love and sees the necessity for writing love letters. He must have spent many years of worry at school and passed examinations in Latin and mathematics, perhaps in French or German, in geography, and many other subjects, all taught in water-tight compartments, yet he is quite illiterate. If he has been slightly higher than the average boy he is able occasionally in after life to quote one or two tags from the Latin grammar and to say that he thought he remembered something of the *pons asinorum*; he is also fond of using the expression, "the unknown quantity x," because it shows that he once worked at algebra. A Premier of Great Britain who had sent out a great military expedition to Cape Breton expressed great delight afterwards when he suddenly discovered that Cape Breton was an island. Chancellors of the Exchequer have shown themselves to be quite ignorant of the simplest arithmetic. A very successful Cambridge coach told me that it is quite common for the father of a pupil to tell him that he does not wish his son to get a good degree. Generalisation is always dangerous, but I think I am safe in saying that Englishmen of the higher classes do not believe in education. They believe in what they call character, which always to them means public school form, and they believe in mental mediocrity, which in most cases means mental inferiority. This gives one explanation of the persistence of the public school system. The man who remembers his years of dull school classroom routine with no intellectual result is not likely to be enthusiastic over the education of his son.

Unfortunately all secondary schools try to copy the public schools. They also aim at teaching good form, mainly by magnifying the importance of football and cricket. To differentiate themselves from the primary schools, they compel every boy to learn through Latin. And all this they do at a rate which suits the pockets of the lower middle-class parent. It is a poor imitation of a system only one part of which is worthy of imitation.

I can understand why Tom Sawyer and his friends, when they started their gang of robbers, initiated them through passwords and a ritual. That was for "side." The gang did not consist of pirates or robbers; they were innocent young boys, and their passwords and ritual were the essence of the romance of the thing. Latin for the average youth seems to me to be merely grown-up Tom Sawyerism, and is allied in obvious ways to the worship of Mumbo-Jumbo. It used to be that the use of fur on clothes was reserved for the higher classes. At another time gentlemen only were allowed to wear swords. In China and Japan certain buttons and coloured dresses indicated certain rank. In our own time there are fashions of slang which distinguish the smart set of society. The survival of Latin and Greek is very much the same sort of thing. It has no more to do with education than the two hind buttons of our coats or the wigs of our judges have to do with convenience. The classics ride us like Sindbad's old man of the sea. All over the British Empire a well-educated man cannot become a professional man of almost any kind unless he pretends to know something of one or more dead languages, such knowledge being of no essential value to him. It is something like what the old Test Act imposed upon us; for 130 years a British citizen perfectly competent to fill the highest posts could not take upon himself the smallest kind of public work unless he could swear to a certain formula. Most of the numerous students of a very important school of mines refuse to take their B.Sc. degrees because they are wise enough to refuse to learn Latin. The mine-owners are wise enough to engage these men if they possess only the college diploma, although they have no degree. There is scarcely one mining engineer holding a university degree in the country that I speak of. Indeed, I may say that only a few mining engineers in Great Britain hold a university degree, and this is for the same reason.

If there is any particularly useless, poor, genteel clerk you will find that his son must be taught Latin. If there is any little township in a new country where everybody is ignorant, the schoolmaster must teach Latin. Any cheap schoolmaster, knowing nothing, worth nothing, will, you may be sure, say that he can teach Latin. If there is a particularly illiterate bar-room loafer in the town who never reads books or newspapers you will find that he has a stock-in-trade of perhaps three Latin phrases which keep him provided in beer.

Do you know why Portia the Maid of Belmont remained so long unmarried? It was because her suitors assumed that the golden language of conquest was Greek and the silver language was Latin. If you read between the lines you will see that this is what Shakespeare meant. His leaden casket signified the English of Belmont-cum-Stratford-on-Avon.

The worst of it is that the average boy who has done almost nothing else than Latin and Greek at school gets absolutely no love for the classics; he never reads a Greek or Latin author after he leaves school. He might enjoy them in translations, but he hates their names, and even if he did not it would never enter his head to read a "crib." Surely this is the natural effect of the schoolroom routine.

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[2] The Report of the Commission on the Education and Training of Officers of the Army (1902) is well worth study. Dr Maguire, the most experienced coach, said, as a witness:—"Latin, as taught to the average schoolboy is pure waste of time, and does not develop intelligence or tend to breadth of culture in the least or facilitate the acquisition of modern languages." . . . "The prominence of ancient classics in English schools and the large proportion of youthful years devoted to failure in regard to them explain the stupidity and incapacity of their pupils as compared with the same class of persons in other advanced communities." . . . "They [classics] are kept in such vogue to suit the convenience of languid schoolmasters who can teach nothing else, and for no other reason whatever." He spoke of "the absurd anachronism of lazy and costly schools, which rendered so many of us ignorant of the very subjects which are generally useful and interesting." He said: "but our educational system all round is utter folly at best." Speaking of English Universities, "the whole system is a grievous absurdity." "'Society' and snobbery are the curses of England."

Following that article in the *Times* newspaper, referred to above, in a discussion, the secretary of the Association for Improving the Teaching of Latin said, "Out of the vast number of boys who learned Latin only a few reached the stage when they could read the classics with any pleasure. A still smaller minority continued their classics after they had left school or the university. The great majority left school with very little, if anything, as the result of years spent in the study of the classics." The next speaker said that the reforms suggested "were based upon the assumption that the present method of classical education was wholly bad. He did not agree." Nor do I agree. I think that if there is one subject that the ordinary public schoolmaster can teach it is Latin. I take the first statement as right, however. I have always said so, loudly, to an unbelieving world that thought me prejudiced, and here we see a lover of the classics inadvertently supporting me, and surely every fair-minded schoolmaster must agree with him, at all events concerning the average boy. It is not the method of teaching that is wrong; it is merely that Latin as a school subject for the average boy must be altogether condemned. It takes from him all interest in every kind of literature; it makes him dislike reading. We must have some compulsory subjects, and I think that any boy may be taught any subject —to some extent; but we ought to have as few of these compulsory subjects as possible, because any subject may be found very difficult by certain classes of intelligent minds. And it is surely ludicrous when a clever mathematician, well read in natural science and fond of English literature, is plucked for his degree because of his poor Latin or Greek. I knew a case where the first classic of his year would have failed to pass his "Little-go" only that special arrangements were made to let him through his mathematics easily. My own career was nearly ruined because I failed in a French examination.

Before a student enters a university he has to pass a matriculation examination, so that we may be sure that he is fit to follow any of the courses of study. In medieval times the one compulsory subject was Latin, because all the literature known to students and teachers was in Latin, all lectures were delivered in Latin, all teaching was in Latin. Consequently in some Oxford colleges a man was fined if he spoke in any other tongue. Then came the time when there was still no English literature, and not only was the best literature in Greek, but Greek was the only approach to natural knowledge, so Greek also was compulsory, and so it has remained to this day—to this day when English literature (including translations) is of greater worth than any ancient or, indeed, any other modern literature; when all teaching, all lectures are given in English, and when our English knowledge of natural science is not only infinitely greater than anything possessed by the ancients; but it enables us to say that the ancients were hopelessly wrong; when nobody but the official university orator or some traveller ignorant of the language of a foreign country speaks Latin and then speaks rather the language of Stratford-atte-Bow than the Latin of the City of the Golden Shields. The men of the City of the Violet Crown were not handicapped by being compelled to learn any other language than their own, to waste their time on mere words; "they were engaged in pursuits of a higher nature, in acquiring a knowledge of *things*. They did not, like us, spend seven or ten years of scholastic labour in making a general acquaintance with two dead languages. These years were employed in the study of *nature* and in gaining the elements of philosophical knowledge from her original economy and laws." The above quotation is from the Langhornes' "Life of Plutarch," and it is particularly valuable as expressing the views of two great classical scholars.

I would make a knowledge of Latin or of Greek compulsory only on students of certain subjects, and the professor ought to impose the condition, not the university. Again, students of certain other subjects ought to know one or more foreign languages, and, indeed, it seems to me that the professor in each subject has a right to insist on his students having certain special knowledge before they enter upon a study with him. But to enter the university, surely the compulsory subjects ought to be as few as possible. It seems to me that the most important thing is to make sure that every student has had an early education through his own language—English; that he should be able to write an account in English of anything he has seen; should have some acquaintance with what are called English subjects, such as geography and history, and the principles of natural science, and the power to make simple computations. All the teaching is to be in English, all his companions speak English; there are good English books on all subjects, there are English translations of all the good books that have been written in foreign languages. So abominable do I think *compulsory* Latin or Greek or French or German that I believe a primary school to be a much better school than any other for a boy if he is fitting himself for any profession in which applied science is important. At present English is not taught properly in any British school. The teachers are all classical men, who are very careful when they write Greek or Latin and exceedingly careless and slipshod when they write English. We might easily write a fairy story about three sisters—Greek, Latin, and English—and call it "Cinderella." The language of the greatest Empire known in history, the Empire of the English-speaking peoples, is not taught seriously in any part of that great Empire. It is shocking to get from a great classical scholar a letter with misspelt words on every page, every sentence being ungrammatical. When will our good modern writers tell us how English composition may be taught to ordinary folk?

I want you to understand that we have established some fundamental principles in our science: (1) A subject must interest a pupil. (2) A man who trains dogs or seals or bears or other animals makes a close study of their minds. In the same way we must recognise that one boy differs from another, and study the mind of each boy. (3) If a boy is not very receptive of an important subject we must do our best with him and try to settle what is the minimum with which we ought to be satisfied. Only a few subjects ought to be compulsory on all boys. (4) There are two classes of boys unequal as to numbers, (*a*) those fond of, and (*b*) those not capable of abstract reasoning. (5) Another two classes are (*a*) those fond of, and (*b*) those not fond of language study. (6) Every boy may be made to write and read in his own language and he may be made fond of reading. (7) The average boy's reasoning faculties are most surely developed by letting him do things. That is, for example, through his sports, or through wood or metal-working, or gardening, or experiments involving weighing and measuring. Through the last of these he learns to compute. A boy of eight learns decimals in an hour if he weighs and measures, whereas by the usual method of teaching he is ignorant of decimals at the age of fourteen. A boy learns whist very quickly if you seat him with three other people at a table with a pack of cards; he would not learn in a month if he had no cards. Would you teach a boy to swim by mere talk? (8) Every boy must get a good deal of personal attention. (9) However good a system may be there can be no good results if the teachers are cheap; cheap teachers are usually stupid and overworked. Men in charge of schools and colleges never seem to learn this. The market price must be paid for a capable man. (10) Fairly good results may be expected from a good teacher, even when he is compelled to work on a bad system, but really good results can be obtainable only from a good teacher with a good system.

I need not go into details about all these principles, but I should like to dwell presently upon a few of them. At the beginning of this address I spoke of the obstruction to great necessary reform—too much antiquated machinery to "scrap." Most schoolmasters will admit the necessity for reform in the case of the average boy, but they say that parents are opposed to the reform. Unbelief in education for the average man is so general among the higher classes that I am afraid we shall have no reform unless some great national disaster causes conversion. There is a lesson for England, and, indeed, for all European races, in the recent history of Japan. The old structure of Japan was in many ways beautiful, but it proved to be without physical strength. Its extreme weakness proved its salvation. Even the teachers of ancient classics saw that for strength it was necessary to let scientific method permeate the thought of the whole population. And now, at the end of the first chapter of Japan's modern history, we find a nation which can not only defend itself, but which retains all of its spiritual life which was beautiful. Every unit of the population can not only read and write, but it is fond of reading, and its education did not cease when it left school. It is getting an increased love for natural science, so that it can reason clearly; it is not carried away by charlatans; it retains its individuality. One result of this is that in time of war Japan has scientific armies. Not only are its admirals and generals scientific, but also every officer, every private is scientific. Everything in the whole country is being developed scientifically, and we Europeans, hag-ridden by pedantry in our schools and universities, refuse to learn an easy lesson. At present we do not even ask what is meant by education or what education is necessary if a particular boy is to be fitted for his life's work. In 1902, when I was president of Section G, and in opening a discussion on the teaching of mechanics at Johannesburg in 1905, I gave my views as to the teaching of a young engineer, but they apply also to the teaching of nearly all boys. These views have been commended by experienced engineers and teachers. To understand me it is first necessary to try to cast away prejudices, and this is especially difficult if one has a pecuniary interest in education. The student of almost any other science than education cares for nothing but the truth; even when he has committed himself to a theory and his good name or credit is at stake the rule of the game is perfectly well known and must be adhered to. The student must not neglect fact or pervert fact; he must be quite fair. The student of physical science sees at once whether or not he is playing the game, because the coordinates are few; there are no complexities, such as we find in our own life problems. This also is why the study of physical science is so good in causing boys to reason, for reasoning can only be taught by constant practice on simple matters which one thoroughly comprehends. Consider a boy's views about ordinary affairs. He is downright. A complex thing must be greatly simplified to him. His painting is in black-and-white; there is no delicate shading in his picture. He never sits on the fence; he is never a trimmer. An historical character is awfully good or awfully bad, very clever or very stupid. A boy is, in fact, cocksure about everything. He is incapable of reasoning about complex things. And when we try to teach him to reason about simple things we must be quite sure that they really are simple to him, that he understands them. For example, many educationists say that the study of geometry is just right for a boy. Well, yes, for 5 per cent. of all boys, boys who can take in abstract ideas. They take to Euclid as a duck takes to water. But for the other 95 per cent. geometry is very hurtful, because unless they continually experiment with rulers and compasses they do not understand what the reasoning is about. In ancient times only very old and exceptionally clever men were allowed to study geometry. We now assume that it ought to be an easy study for the average English boy. Generation after generation we stupefy the average English boy with demonstrative geometry, and we call him a duffer so often that he thinks himself a duffer, and even his mother thinks him a duffer, and, inded, we have done our best with geometry and Latin to make him a duffer. Only for his football and cricket, which teach him to reason a little, he would become a duffer. And yet in my opinion if this average boy were properly taught in school he would prove to be very superior to the boy who is usually called clever. The schoolmaster calls a boy clever because he is exactly like what the schoolmaster himself was when a boy; but I am afraid that I place little value on the schoolmaster's cleverness, whether as a boy or a man. Reasoning can be taught through almost anything that a boy does, but more than all things through his experiments in natural science. Formal lessons on reasoning, on logic, are utterly useless, and I may say that set lessons on almost any subject are utterly useless for the average boy.

Milton's poems are greatly praised. Well, I am not going to say a word against the people who talk in public about the most wonderful epic in our language and who never read it; but how many people have read Milton's magnificent prose works? Milton first taught me the true notion of education, that the greatest mistake is in teaching subjects in water-tight compartments. It is the idea underlying one of the most instructive books ever written, "Sandford and Merton." When teaching a subject, teach all sorts of other subjects as well. If Mr. Barlow's boys were interested in astronomy he showed them stars and planets through a telescope for a night or two, but he gave them no stupefying course on astronomy. He gave them stars and the solar system just as long as they were interested. He used a globe as well as mere maps in teaching them geography and history, but the soul-destroying idea of a course of study on "the use of the globes" did not commend itself to him. They walked over the fields and took an interest in trees and flowers, but he gave them no stupefying course on botany. When he gave them a lesson on English grammar or literature he taught them at the same time the geography and history and the fairy stories of their country. How can a man give a course on grammar or geography or history or anything else without diverting his talk in an interesting way to other subjects? What is so tremendously important about natural science laboratory work is that a student must be thinking all the time about the same matters, not from one but from ten interesting points of view. He is not merely observing, he is measuring, he is computing, he is reasoning; he has to write out descriptions of what he sees and does, and he thinks then of his spelling and grammar; he has to sketch; he has to read books about what other people have done before him on the same subject, and also for statistics. He learns the value of a bit of work done in a clean honest way, and when he gets some more experience he glows with the feeling that he has really added to the knowledge of the world. He is a discoverer, and he feels the emotion of Cortez! It is marvellous the alteration which has occurred in the mental attitude of the common average boy. Instead of feeling that he is a degraded slave he feels the emotion of his childhood returning to him. He once made the great discovery at the age of six that the back garden was inhabited by fairies and lions and Indians and pirates. He was the Caliph Haroun Alraschid for a while. And now, after a wretched life at Latin and Euclid, a new revelation is vouchsafed to him, and as he gathers years he finds that nature is placidly willing to let him steal her secrets little by little, one by one, secrets that are gradually changing men from the bewilderment and spirit possession of the Middle Ages; so that at length he enters into complete communion with nature and rollicks with her, and quarrels with her, and loves her more and more until he dies. And his reasoning power has been growing all the time, so that more and more he understands complex things, for, after an experimental study of story-books, he probably entered the kingdom of Shakespeare at the age of fourteen. Things requiring memory can be learnt only in early life—weights and measures, the multiplication table, languages. He knows games involving spelling. But, over and above all these, he has from infancy repeated all sorts of poetry long before he could enjoy much more of it than the jingle of its rhyme.

Education consists in the development of a man from his earliest day, and does not cease until he dies. Any thoughtful man must see that there is no science so important as that of education, the preparation of children of this generation to be the citizens, the rulers of the country, in the next generation. The whole future of our Empire depends upon the education of the children. By the study of this science we hope to improve teaching so as to make future citizens not only to have more knowledge and more skill, but to make them wiser than the people of the present or the past.

Early training determines what later training ought to be. Let us consider what the early training of a boy ought to be. In his very early days nature has provided that his education shall proceed very rapidly by observation and experiment, and the only teaching needed is through careful nursing and affection. He teaches himself, and he loves to learn. He ought to get toys not too realistic, for he loves to weave romance round his toys, but still things to observe and experiment with. He has most complex problems in physical science when he is only a few weeks old, the solution of which involves much labour, but it is pleasant labour and he is happy. And he will remain sweet-tempered and happy and unspoilt if there is real affection from his teachers. If, however, somebody teases him by playing practical jokes, or if a selfish mother who was unreasonably kind to him yesterday is unreasonably unkind to him to-day, he gets, because of his reasoning power, a sense of injustice. Man, woman, or child with a sense of injustice may be said to be possessed of a devil. During the first six years of a child's life the creation of its power to reason is more wonderful than anything else, and this reasoning power comes altogether by observation and experiment. An affectionate parent easily finds methods of helping nature in this process. The unspoilt boy of six years seems to forget nothing that he hears; he has gathered a most wonderful vocabulary; he knows endless nursery rhymes and simple poetry; he is as active and adventurous as a kitten, and everything he does is cultivating his senses. This is the time when he fills the smallest playground (which to grown-ups seems bare and desolate) with giants and fairies and Indians and pirates, with forests and mountains and rivers and oceans. His imagination is so extraordinary that the most uncouth creation of his own gives him exquisite pleasure. Why do I dwell upon this stage of a boy's development? Because it has been so perfect. Nature has learnt to do this to children during perhaps hundreds of thousands of years, and it has been the most important time of a boy's life, the time when, if parents will only give the boy their love and greatly let him alone otherwise, he develops mentally more than during all the rest of his life. Speaking broadly, he has done nothing in all this time except what nature and affection made pleasant to him. I have studied the science of education and practised the art of teaching all my life, and I say that all our failures are due to our neglect of nature's methods, and our schools destroy the good effects which nature has produced.

As a rule I do not like to be told that certain subjects must be compulsory, but surely every child of eleven must have some such qualifications as these: (1) The power to speak and read and write in his own language. (2) To be able to do easy computation. (3) To have an exact knowledge of the simplest principles of natural science from his own observation and experiment. I think that every observer must acknowledge that these powers are possible for almost every boy of eleven. Some of us have for many years been endeavouring to show how the child of six may acquire these powers by the age of eleven if nature's methods—that is, kindergarten methods—are followed. For example, he plays at keeping shop, selling or buying things by weight and measure, and paying or receiving actual money and giving change. He weighs and measures with greater and greater accuracy as he makes experiments in mechanics and heat and chemistry. Every boy is fond of stories, and if treated reasonably is easily induced to learn to read. Reading aloud is easily made a pleasure and a habit, and so the boy learns to speak properly. Any boy whatever will become fond of reading if the people about him are fond of reading: I state this as a fact which I have investigated. A boy who is fond of reading gets later on to know the value of books and the use of books, and he will go on educating himself until he dies. Any attempt at coercion, unless it is the very gentle coercion of a person whom he loves, is fatal; even coaxing is not always good. He assimilates knowledge from everything which he does, and therefore he ought to be induced to do things which not only keep him healthy, but which give him knowledge and teach him to reason. Do you remember how angry Lanfranc of Bec was at the idea that any pupil could be *forced* to learn; he said "it turned men into beasts." I speak to you who love children, who love young people, who know that there is scarcely one child in a hundred, even among rather spoilt children, who does not love to do his duty.

Under the best and most loving of teachers a lonely child has enormous disadvantages, but these can generally be remedied. The usual mistake is to send it to a large school. If it is merely a day school there is no great harm. But no child under thirteen ought to be sent to a boarding school unless it is a small school and the master and his wife have a love of sympathy for other people's children. There are such people in the world, God bless them! but they are not numerous. They are so few that we must return to nature as the best of teachers. The time is coming when a child's own father and mother will have much more knowledge and wisdom than they have now, and they will refuse to give up to others the doing of their highest duties. It is at present not sufficiently recognised that the most important duty of the parents is the education of their children. At present, men who are building up fortunes are too busy to think of their children, and so we find that the sons of Lord Chancellors and other successful men have been marrying chorus girls and squandering those very fortunes to which their education was sacrificed. Of course, if parents are uneducated, and therefore selfish or otherwise foolish, any kind of school may be better than home for their doomed children. It is one of the great advantages of poverty that the children go to day schools and they keep in touch with home life. If the day school is really a boarding school as well, it will be found that there is always a differentiation in favour of the boarder, which has a very bad caste effect, just as the "modern-side" boy of any public school suffers in character because he is of a lower caste than the classical-side boy. It is usual to remove a stupid classical-side boy to the modern side, and every boy on the modern side has a sense of injustice. The work of the modern side ought to be much the higher, but it is always badly done because the atmosphere is altogether bad.

It may be said that I am only destructive in my criticism of public schools. I think it will be found that I am also constructive, although I acknowledge that my sketch needs much filling in. Well, can much more be done in an address lasting one hour? I will now try my hand at a little filling in. I have no objection to the existence of classical schools something like the present for boys who are fond of classics. The average boy will not be asked to attend such a school. I feel sure that much greater attention ought to be paid to the teaching of English composition, to English poetry and prose, and to English subjects generally. I also feel sure that much attention ought to be paid to natural science. And surely it can do no good for the classical masters to go on sneering at natural science subjects and calling them "stinks" as they do now.

I want, however, to speak more particularly of a much higher kind of school, which will educate the boy usually called clever and also the boy usually called stupid. As I have already remarked, I think that these names may sometimes be redistributed.

The school is one for boys from eleven to sixteen years of age. It ought in no way to be connected with any classical school. English subjects will predominate, but teaching in Latin and Greek and modern languages and other alternative subjects will be provided, although they will not be forced upon any boy. The masters who teach English ought to know enough Latin and Greek and Celtic and Old English and modern languages to be able to illustrate the derivation of English words through their roots. And they must be well read in English subjects and fond of English literature. They will make the boys fond of reading English, and encourage them to find out what they like best. Some boys will take to history and philosophy, some to poetry and imaginative literature. Every boy ought to get the best chance of developing his faculties. It may be asked—if we cannot make the average boy spend or waste twelve hours a week on Latin, what are we to do with him? At all events, now, we keep him doing something, even if it is only marking time. My answer is, you think only of his putting in time; well, then, let him put in his time at work that interests him; any work of that kind must be educative under an intelligent master who can help him in his studies if it induces him to look up information for himself. Thus, when reading travels or history, he will use the globe and raised maps and read geography, and hunt up plans of battlefields. Think of the things that a boy used to be punished for doing, and let him do those things under wise direction. I used to be punished for reading Scott and Cooper. Nowadays prizes are given to boys for their knowledge of Ivanhoe or Quentin Durward. Expand this into a system. A boy who loves to browse over Chambers's English literature ought to be guided in his browsing, and induced to take up something more than selections, and he may easily be induced to get off selections by heart if his teacher does not show his contempt by speaking of such exercises as ***Rep.*** (repetition).

Let the teacher take a leaf out of our methods of teaching chemistry and physics. It has been shown that twenty-five boys doing work in the laboratory during a lesson of an hour and a half or two hours can be managed by one teacher. Experimental lectures in a lecture-room have now been greatly discarded; such lessons as I speak of take place in the laboratory, but reliance is placed particularly upon the personal attention of the teacher being given to each group of students in charge of an investigation, the group not being usually greater than four in number, and often being less than two. These students are sometimes merely verifying or testing a statement made by the teacher or found in a book, but they are often finding out things for themselves. One idea underlying the work is that there ought to be more and more illustrations of simple fundamental principles. It is long before these simple things really become part of a boy's mental machinery; things like the mere definition of *force*, for example. It is, of course, quite different work for the teacher from anything that he used to have to do; for one thing, being much more exhausting. He cannot shirk his duties and sit down waiting for students to come to him. When teaching degenerates into mere maintenance of discipline, everything being regarded as right if the pupils are quiet and seem to be diligent, it is necessary to make a radical change, usually a dismissal of the teacher. It used to be that a science master gave an experimental lecture, and afterwards he had a very easy time, letting the students follow a set routine in the laboratory, but this will no longer do; such attendance at lectures and laboratory work means poor mental training.

Now, I would work out a system for English, English composition, English poetry and prose, geography, history, and other English subjects, on the lines that we have found so successful in natural science. An enormous change has been effected during the last fifteen years in the teaching of mathematics. The older methods always failed with the average boy or man. The new system, which is sometimes called *practical* mathematics, is based on the idea that students shall work experimentally, just as they do in their natural science. It is found that their eyes and faces are bright, they work hard, and they evidently enjoy their work. We have merely introduced common sense into the teaching; we have approached the student's mind from other points of view than the old academic one, from the only side on which he has ever been taught anything—the side of observation and trial. He weighs and measures. He does experimental geometry and mensuration, and is assisted by abstract reasoning just to the extent which interests him; he makes plans of the school buildings and maps of the district; algebra becomes interesting when in coordination with experiments in mechanics and physics; trigonometry becomes interesting in the actual measurements of heights and distances. The infinitesimal calculus is bound to be a weapon which any boy of fifteen easily gets to understand by actual use when he is dealing with dynamic experiments. In fact, the physical and mathematical laboratories are in one, and the same teacher takes charge of both subjects and teaches them as much as possible together.

Furthermore, in the preparation of an account of an investigation there are practical lessons in English composition; there is sketching, and also more careful drawing with instruments, and the finding of empirical laws, using squared paper. In such a school every subject is being taught through all the other subjects; every boy is doing the work in which he is greatly interested, and no boy is attending merely and putting in time. Furthermore, out of school-time there might be the usual restrictions as to "bounds," but otherwise I would let a boy do pretty much as he pleased. "Prep." at boarding-schools and home lessons for boys at day schools are to be quite discredited. I would—it may cost a little more money—allow a boy to work in the workshops or laboratories or library or in his own room or common rooms at anything he pleases in this off-time, and I would give him advice only if he asks for it. If I saw a boy reading a penny dreadful I would not stop him; nor if he were reading Paine's "Age of Reason," or any wretched treatise on psychology or logic. I would in no way discourage a boy from acquiring a greater and greater fondness for reading, knowing that this is the foundation of future happiness and education, and that no harm which he can get from his reading is of the slightest importance in comparison with the importance of our main object. As he grows up he will become less and less fond of the sixpenny magazine. The school can at its best be merely a preparation for the lifelong education of the man. I would not keep the boy at school after sixteen. Let him then go into business, or to a science or technical school, or to the university.

Unfortunately for the present no university will take men without an entrance examination involving other languages than English. This is a great evil, but it is not going to last much longer. In the meantime a competent coach will prepare any student to pass the necessary examinations (say, in Latin and Greek) in three months, even if there is much other work to do. This is not a matter of learning any classics; it is rather the manufacture of some contempt for the classics, a necessary evil for the present. Indeed, for the present, but let us hope not for long, there are many other necessary evils. We have to find competent enthusiastic teachers, we have to persuade governing bodies to pay salaries two or more times as great as at present, we have to make parents see that some mental training and fondness for reading and writing are really of value, and that Tom Sawyerism is only childish.

The importance of primary education is now well recognised. Rich and aristocratic folk know that they are now in the hands of the common people in a democratic country, and it is important to see that the common people shall be made fit to rule and shall have a real sense of fairness and reasonableness. Above all, if they are to be good citizens we must cultivate their common sense. I think that in the schemes and the administration of primary education by the Boards of England and Scotland it is in a good way; but there is one great curse upon it, and the enormous sums of money spent upon it are greatly wasted. The local authorities give to every teacher far too much to do, and they give him only half his proper wages. In a few years the Government of our democratic country will be in the hands of the boys now at school. That they should be good citizens full of common sense is more important than any other thing. If they are without fondness for books, and if they cannot reason, their votes will be at the command of fraudulent or foolish, or perhaps only selfish or self-deceiving speakers. Our Empire was ruled by George III., and by God's grace we only lost America and piled up the National Debt; but think of an empire ruled by millions of Georges! Teaching the young requires great wisdom and sympathy, and we entrust it to people paid half wages, the "otherwise unemployed." In the secondary schools also we find this penny wise pound foolish policy, and it is particularly evil in the great technical schools. A city is proud of its magnificent college of science, first because of its architecture; secondly, because of its equipment in apparatus, perhaps in steam- and gas-engines and other expensive machinery. And the man in charge of the most important department of that college receives perhaps 250*l.* a year. He ought to get at least 600*l.* That is the market price of a fit man, and without a fit man the whole money and the time of students are being wasted; the thing is really a fraud, a whited sepulchre, and, of course, the principal is always a classical non-scientific man. Photographs of the building and its laboratories are very fine to look at in guide-books of the city, and the managers of the college get public thanks for their services. I know nearly all the technical and science colleges of Great Britain, and I scarcely ever see any of their complacent managers, members of their governing bodies, without wishing that I had some of the powers of the familiars of the old Spanish Inquisition. What right have they to undertake duties which require a knowledge of natural science?

The latest proposal of our callous copiers of the Germans is to make attendance at evening classes compulsory up to the age of seventeen. At present working boys attend evening classes voluntarily, although in many cases they are too tired to learn much. Yet many of them do learn. These boys are almost martyrs. They sacrifice so many of their poor pleasures, and indeed duties, that they certainly deserve success in life. But it is not fair to impose these sacrifices upon boys who are, as apprentices, learning the principles underlying their trade, and who are paid only small wages on the understanding that their masters teach these principles. In 1889 I introduced a Bill into the Kensington Parliament compelling employers to provide such instruction during the working hours. Reforms of all kinds proceed with exasperating slowness, but already many employers are carrying out this idea.

In some things we reformers have made way. It is now recognised almost everywhere that examinations ought to be conducted mainly by the teachers of a student. I have often put the matter in this way: Huxley used to teach about forty students in biology; we cannot imagine better teaching. But if those students had only wanted to pass the examination of London University it is quite certain that they would have done very much better by attending the class of a cheap crammer. A university consisting of two, three, or more federated colleges is very little better than a mere outside examining body, and this is what London University has always been. I am glad that a change towards something better is now about to take place. A number of separate universities would be better, but in two years or less, probably, the colleges of London will conduct their own intermediate and degree examinations. One result will be that when a man gets his degree he will not shut up his books for ever.

I would, however, point out that Old London University, which was a mere examining body, served an exceedingly important purpose. This statement may seem curious coming from a person who has always railed at London University as a mere examining board. I still say that it was never a University at all in the past. But a man reading hard by himself, perhaps far away from a college, could have a severe test applied to his acquirements which encouraged him in his studies when he had no other encouragement, and the test was very rightly a severe test. To do away with its outside examinations altogether, as I believe is the intention of the authorities, will be exceedingly harmful. It would be impertinent in me to make a suggestion as to the distinction which might be made between a degree conferred by his own professors upon a man who has attended regularly a college of repute, and a degree conferred by a mere examining body upon an outside student. For the first, the examination test may be easy. The Oxford and Cambridge pass degree examinations are quite easy, and rightly so, for the real qualification is that an undergraduate shall have lived for three years in the intellectual and cultured life of an Oxford or Cambridge college. In the other case the mere examination is the only test, and it is rightly very severe. The two kinds of degree differ altogether in quality. In a new country of great distances I can imagine many good secondary schools to be established having neither sufficient funds nor sufficient pupils to be qualified as universities. Yet it may be of enormous importance that a few of the older pupils at such schools should as external students be examined for degrees by distant universities, which, in such a case, are merely outside examining bodies. I can see the gradual increase in importance of such secondary schools leading to the establishment of something higher—namely, colleges of university rank—and I can see such affiliated colleges becoming universities themselves perhaps after a period in which two or more of them federated themselves as universities. But I say that there ought always to be some examination machinery by which a student who is too poor or who through any other circumstance is unable to attend a university college may be encouraged to study by himself, by having his attainments tested.

In this address I have said nothing about the education of women. I have always advocated higher education for girls, but it is surely wicked to teach girls as if they were boys. Men are concentrative, and they specialise; women observe more and more about many things, and they really have more capacity for acquiring mental power. Until quite recently girls were saved from stupidity, but the high schools are now giving a crammed knowledge of facts and of the opinions of the tribe, so that girls and women are ceasing to think for themselves. The education of men is in a bad way, but that of women is becoming much worse.

I think that in this address I have put forward no idea that I have not already published time after time in the last thirty-five years. I put these views forward again because, after much thought and much experience, I still think them to be correct, and I feel sure that they must prevail. But I must confess that it is only a very hopeful man who can peg away at a thankless task as Dr. Armstrong and I have been doing so long.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—Dr. A. W. Stewart, lecturer in organic chemistry in the Queen's University of Belfast, and formerly lecturer in stereochemistry at University College, London, has been appointed lecturer in physical chemistry at the University of Glasgow, in succession to Prof. Soddy, now of Aberdeen.

BY the will of the late Major-General Tweedie, his estate of Lettrick, in the parish of Dunscore, having an annual value of about 180*l*., is bequeathed to the University of Edinburgh. The annual income is to be applied by the University to the establishment of scholarships for research into the early history, development, and religion of Eastern peoples; or in such way as may seem best suited to advance that branch of study.

THE leading article of the August issue of the *Reading University College Review* deals with the teaching of applied science, and the question is considered from the point of view of chemistry. The writer urges that given a due knowledge of pure chemistry, all that is required for the mastery of any branch of applied chemistry is concentration on those analytical methods and physical problems which belong to it. Thus to succeed in any applied branch of the science a man must first be a pure chemist. He goes on to argue that the system of instruction in applied sciences followed in this country attempts too much and does too little. The syllabus should be restricted, while more time should be devoted to general principles. The applied part should not be taken separately, but should be interwoven with the rest and used to illustrate it. Speaking generally the student of applied science will profit most if his work in pure science is designed to give him adequate training in scientific method.

THE calendar for 1914–15, that is, for the ninety-second session, of Birkbeck College, London, has been received. Full provision has been made for continuing the work of the college during the present academic year in the direction of supplying approved courses of instruction for degrees in arts, science, laws, and economics of the University of London, and offering other important educational facilities. The usefulness of the college is much curtailed by its limited accommodation: its pressing need is for increased space. More extensive college buildings, with additional classrooms and larger laboratories better adapted to modern requirements, would give a great stimulus to the work of the college and add to its public utility. Attention is directed in an introduction to the calendar to the final report of the Royal Commission on University Education in London (1913), in which the Commissioners write (section 248): "We think that the original purpose of the founder of Birkbeck College and the excellent work that institution has done for the education of evening students who desire a university training, mark it out as the natural seat of the constituent college in the faculties of arts and science for evening and other part-time students."

A COPY of the annual report, for the year ended March 31, 1914, of the Education Committee of the County Council of the West Riding of Yorkshire has been received. The report contains much evidence of sound progress during the year. The arrangements with the Universities of Leeds and Sheffield under which, in virtue of the general grants made by the County Council, certain definite work is undertaken by the universities and certain free places are reserved for nominees of the County Council, have been continued. In addition to external lectures on coal mining, given by the University of Sheffield, both Universities have been engaged also in the organisation and supervision of classes in coal mining, the Leeds University in the area of the West Yorkshire coalfield, the Sheffield University in the area of the South Yorkshire coalfield; and each university has made provision for the training in mine-gas testing, of persons selected by the committee as prospective teachers of this subject. The Joint Agricultural

Council of the three Ridings of Yorkshire has continued the work connected with education and instruction in agricultural subjects, acting through the agricultural department of Leeds University, on the same lines as before. Full particulars are given of the council's scheme of scholarships and exhibitions. This provides assistance for persons desirous of obtaining instruction in all grades of education other than elementary. It provides for the properly qualified pupil in the elementary school who desires to proceed to a secondary school and furnishes him at a later stage with the means to enter a university; it also offers instruction to boys and girls who have commenced work in office or mill and can devote only their evenings to the continuance of their education, as well as to the craftsman who desires to increase his usefulness by further study. For the benefit of artisans and workers in the leading industries of the West Riding, such as the textile trades, engineering, coal mining, and agriculture, a number of technological scholarships and exhibitions have been set apart to enable the holders to go through specialised courses, usually of two years' duration. Technological scholarships were held in 1913–14 by five engineers and five textile workers.

BOOKS RECEIVED.

Chemical Engineering: Notes on Grinding, Sifting, Separating, and Transporting Solids. By J. W. Hinchley. Pp. viii+103. (London: J. and A. Churchill.) 2*s*. 6*d*. net.

A Manual of Dental Anatomy, Human and Comparative. By C. S. Tomes. Seventh edition, edited by Dr. H. W. M. Tims and Prof. A. Hopewell Smith. Pp. vi+616. (London: J. and A. Churchill.) 15*s*. net.

Functions of a Complex Variable. By Prof. J. Pierpont. Pp. xiv+583. (Boston and London: Ginn and Co.) 20*s*. net.

Text-book on Wireless Telegraphy. By Prof. R. Stanley. Pp. xi+344. (London: Longmans and Co.) 7*s*. 6*d*. net.

Methods of Quantitative Organic Analysis. By P. C. R. Kingscott and R. S. G. Knight. Pp. x+283. (London: Longmans and Co.) 6*s*. 6*d*. net.

Records of the Survey of India. Vol. iv. Explorations on the North-East Frontier during 1911–12–13, under the direction of Col. S. G. Burrard. Pp. 91. (Calcutta: Government Printing Office.) 6*s*.

Transactions of the Geological Society of South Africa. Vol. xvii. January–June. Pp. 59. 21*s*. Proceedings of the Geological Society of South Africa, to accompany vol. xvii. of the Transactions, January–June, 1914. Pp. xlix. (Johannesburg: *Transvaal Leader*.)

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College, July, 1914. Edited by R. M. Milne. Pp. 22. (London: Macmillan and Co., Ltd.) 1*s*. net.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. xliv. January to June. Pp. 240. (London: Royal Anthropological Institute.) 15*s*. net.

The Government-General of Formosa. Bureau of Communications. The Climate, Typhoons, and Earthquakes of the Island of Formosa (Taiwan). Pp. iii+80. (Taihoku: Meteorological Observatory.)

Soil Management. By the late Dr. H. F. King. Pp. ix+311. (New York: Orange Judd Company; London: Kegan Paul and Co., Ltd.) 1.50 dollars net.

Rural Improvement. By F. A. Waugh. Pp. xi+265. (New York: Orange Judd Company; London: Kegan Paul and Co., Ltd.) 1.25 dollars net.

Hunt and Burkett's Agriculture. Farm Animals. By Profs. T. F. Hunt and C. W. Burkett. Pp. ix+534. (New York: Orange Judd Company; London: Kegan Paul and Co., Ltd.) 1.50 dollars net.

The Manchester Municipal School of Technology. Calendar, 1914–15. (Manchester.)

Conferencias de Seismologia Pronunciadas en la Academia de Ciencias de la Habana. By M. G. Lanza. Pp. xvi+157. (Habana: Lloredo y Ca.)

Van Nostrand's Chemical Annual, 1913. Edited by Dr. J. C. Olsen. Pp. xiv+669. (London: Constable and Co., Ltd.) 12*s*. 6*d*. net.

Outlines of Applied Physics. By H. Stanley. Pp. viii+227. (London: Mills and Boon, Ltd.) 2*s*. 6*d*.

Department of Agriculture. Behar and Orissa. Crop Pest Handbook for Behar and Orissa (including also Western Bengal). Pp. xxiii+leaflets 84+appendices 21+plates liv. (Calcutta: Thacker, Spink and Co.) 4 rupees.

The National University of Ireland. Calendar for the Year 1914. Pp. clvi+476. (Dublin: National University.)

Leeds Astronomical Society. Journal and Transactions for the Year 1913. Pp. 106. (Leeds: R. Jackson and Son.) 2*s*.

DIARY OF SOCIETIES.

WEDNESDAY, OCTOBER 7.

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THURSDAY, OCTOBER 8, 1914.

GERMANY'S AIMS AND AMBITIONS.

LORD ROSEBERY, on March 1, 1893, speaking at the Royal Colonial Institute, said: "We have to remember that it is part of our responsibility and heritage to take care that the world, so far as it can be moulded by us, should receive the Anglo-Saxon, and not another character." If we inquire what is conspicuous in the Anglo-Saxon character, most people will agree, I think, that it is based on regard for our neighbours' rights, a regard which has been the object of our laws and struggles for centuries. The Anglo-Saxon spirit is essentially one which makes for fair-dealing; the race has never been a race of oppressors. Equity, truth, and justice have been our watch-words; and on the whole the nation has acted up to its convictions. It is this national feeling which has led to our taking part in the present war; rather than see a treaty broken, rather than allow a small nation to be coerced into an immoral act by a large and powerful one, we have lent our aid to the French and the Russians, and we are all prepared to support to the death what we all believe to be a righteous cause.

The German view of a nation's duties is very different, and wholly irreconcilable with that of the British and Americans. In the first place, we regard the State as ourselves; we are the State. Representative government leads to this conclusion; if we do not like the policy of our representatives we can change them. But for the German race the State is an external, self-elected body, possessing absolute power over the lives of its subjects. It is for the State to determine what is best; with an army at its back it is useless to attempt to oppose its decisions. The essence of the Teutonic character is to compel everyone to obey what it conceives to be for the good of the community. While the Anglo-Saxon motto may be conceived as "live and let live," the Teutonic command is "live as the State would have you live."

The Anglo-Saxon ideal is the freedom of the individual; the Teutonic ideal the compulsion of the individual by an omnipotent oligarchy.

The effect of the applications of science to practical ends has, during the past century, been the great prosperity of the civilised world. The standard of living has been immensely improved; disease has been diminished, and the average duration of life has been much prolonged. Moreover, the use of machinery has greatly economised energy; the effective production of the race has enormously increased. As a concomitant, the density of the population in European, and indeed in all countries, has also increased, and ever in increasing ratio. It is obvious that such increase cannot go on indefinitely; up to now the accumulation of population has to some extent been modified by emigration; but here, again, there must be a limit. That limit, however, is still a distant one for England; her colonies are still capable of absorbing an enormous population. This is doubtless the reason why British statesmen have practically left unconsidered the economic problem of the increase of population beyond the possibility of feeding it. Moreover, it is not the Anglo-Saxon spirit to prepare to face future difficulties; each difficulty is grappled with when it arises. Not merely is this the character of our race, but our democratic government renders any other course of action practically impossible.

German, or, to be more accurate, Prussian statesmen, have foreseen that difficulties will arise, owing to the natural increase of the German people. Her colonies are relatively unimportant; moreover, they are badly administered, and do not attract settlers. It is true that enormous numbers of Germans have emigrated; it is said that there are no fewer than a million Germans in Brazil; and a very much larger number has found a home in the United States. But these are no longer under German rule; they regard themselves as emancipated, and soon lose connection with, and affection for, their native land. This is naturally repugnant to the Prussian ruling class; and their remedy is war.

The doctrines of humanity are deeply rooted in the Anglo-Saxon spirit; lives are preserved which do not represent a high standard of health and strength; and what may be termed the "virility" of the population decreases. Again, our legislators, though aware of this fact, have taken few steps to face it, if indeed any practical steps are possible. German statesmen, on the other hand, have attempted, by the physical training inseparable from universal military service, to improve the condition of the partially unfit. They imagine that they have secured an advantage over other nations by doing so; and their ideal, with which they have infected practically all Germans, is to secure world supremacy for their race, in the conviction that the condition of humanity will thus be ameliorated. This is the aim which has permeated all classes of German society during the past generation; this is the cause of the present war. No means are to be neglected to secure this end; righteousness, truth, and justice are to be sacrificed in order that the German race may persist. The German nation has been educated to believe in this ideal by the Prussian ruling caste: "Deutschland über Alles in der Welt." Therefore the war.

Now it may be pointed out that the youth and early manhood of the race are the fighting class; and that by war the most able-bodied of the population are, at least partially, eliminated, with the inevitable result of the deterioration of the race as a whole. Probably it would be argued by Prussian statesmen that the relative number of deaths in war is small; and a successful war will leave abundant healthy men to perpetuate the race. Deterioration by the effects of war, they may contend, is not so wide-spreading as deterioration by the saving of lives of little value.

I have tried to state the case for the German nation; it represents an attempt to aid the elimination of the unfit, the unfit being all who do not hold with German ideals.

Now a race with such an ideal becomes impossible. It cannot be denied that Germany has contributed much in the past to literature, to science, and to the art of music. Individual Germans have attained the highest eminence, and have gained universal admiration. But the originality of the German race has never, in spite of certain brilliant exceptions, been their characteristic; their *métier* has been rather the exploitation of the inventions and discoveries of others; and in this they are conspicuous. The same obedience to command and the same attention to detail may be noticed in their industrial and scientific work as in their army. And of recent years, according to common report, commercial morality among the Germans has been at a low ebb. They are disliked as business men; their methods are not regarded as fair, or their word as trustworthy. Even in the world of science this spirit is by no means unknown. In spite of their boasted progress in what they imagine to be civilisation, they have been relapsing into barbarism. And the execrable deeds of their army—murder of defenceless non-combatants, destruction of priceless buildings, heartless cruelty to women and children—all these are merely the outward and visible sign of their spiritual beliefs. The aim of science is the acquisition of knowledge of the unknown; the aim of applied science, the bettering of the lot of the human race. German ideals are infinitely far removed from the conception of the true man of science; and the methods by which they propose to secure what they regard as the good of humanity are, to all right-thinking men, repugnant. These views are not confined to the Prussian ruling caste, although in it they find active expression: they are the soul of the people.

The conclusion is that this war is a war of humanity against inhumanity; of principle against expediency; of right against wrong. Fortunately, the present aspect of the war is favourable to the Allies; and justice and mercy will undoubtedly triumph.

What is to be justice and mercy? First and foremost, reparation must be made to the Belgians for the outrages which they have suffered; next, France must claim not only damages for the present invasion, but for the indignities of 1871; Russia and Great Britain will no doubt demand compensation. The motto of the Allies must be "Never again." Not merely must the dangerous and insufferable despotism which has eaten like a cancer into the morals of the German nation be annihilated, but all possibility of its resuscitation must be made hopeless. The nation, in the elegant words of one of its distinguished representatives, must be "bled white."

Will the progress of science be thereby retarded? I think not. The greatest advances in scientific thought have not been made by members of the German race; nor have the earlier applications of science had Germany for their origin. So far as we can see at present, the restriction of the Teutons will relieve the world from a deluge of mediocrity. Much of their previous reputation has been due to Hebrews resident among them; and we may safely trust that race to persist in vitality and intellectual activity.

It would be unworthy of the dignity of scientific men to imitate the example of some of the German professors in "abandoning the distinctions conferred on them by English learned societies." It must be remembered that the award of distinctions to Englishmen has been the act of the older race of German men of science, who form the councils of the various academies. Doubtless these men deplore the degradation of their race, as manifested in the outburst of barbarism which has shocked the feelings of the whole world, and it would be a graceful act if English men of science were to retain the marks of their appreciation.

In conclusion, it cannot be contended that the present war has in any sense been promoted by the imagined spread of education and science in Germany. It affords to all men a lesson, however, that the moral sense of a nation requires educating, as well as the intellect; that a regard for truth, and for the sanctity of a promise are more important possessions than a knowledge of recent discoveries and inventions; and that the intellectual progress of a country is to be measured by the intelligent participation of every citizen in problems of government and of advance in the moral and mental conditions of the race. The splendid response to Lord Kitchener's call to arms shows that, in spite of many small and annoying eddies in the stream of British life and thought, it still flows steadily in the good old channel of probity and honesty.

WILLIAM RAMSAY.

THE GEOGRAPHY OF THE BRITISH EMPIRE.

The Oxford Survey of the British Empire. Edited by Prof. A. J. Herbertson and O. J. R. Howarth.
The British Isles, and Mediterranean Possessions (Gibraltar, Malta, Cyprus). Pp. xii+596+7 maps.
Asia, including the Indian Empire and Dependencies, Ceylon, British Malaya, and Far Eastern Possessions. Pp. x+505+5 maps.
Africa. Pp. xvi+547+5 maps.
America. Pp. x+511+6 maps.
Australasia. Pp. xii+584.
General Survey. Pp. viii+386+1 map. (Oxford: Clarendon Press, 1914.) Price 14*s.* net each.

THOUGH arranged as a series, these volumes can, it would appear, be bought separately. Each volume has the same preface, and the order in the series is distinguished on the back by stars instead of numbers, so as to conceal the oddness of an odd volume. Each volume is by several authors, who have obviously, each as an expert in his own branch, been left a good deal to themselves as to the manner in which their own subjects are to be treated. Each volume is provided with an index, with coloured folding maps showing the physical features, geology, or political divisions of the regions dealt with, with text-maps and diagrams, largely climatological, in black and white, to illustrate the same or other things, and with plates giving illustrations of typical scenery. Each volume, too, has at the end another useful feature, a set of statistical tables, or tables and diagrams relating to the dominions dealt with in the volume, those in the last volume being of a more general and comprehensive character. All the volumes except the last, moreover, have a short gazetteer or alphabetical list of the more important places mentioned in the corresponding volume, with a statement of the situation, and notes as to points of interest. This arrangement will obviously facilitate the bringing up to date of later editions.

The editors are to be congratulated on the success with which the whole work has been carried out. They have obtained the services of a large number of highly competent men, and all those interested in the Empire will feel that they owe them a debt of thanks for the mass of trustworthy information that has here been accumulated, and the instructive statement and discussion of problems connected with the Empire as a whole or its different parts.

In the treatment of each of the larger Dominions there is the same general arrangement of topics, but there is no pedantic adherence to the same grouping of these under chapters. It would have been worse than pedantic to have exactly corresponding chapters in dealing with units so diverse as the British Isles, India, and the Dominion of Canada. In the treatment of the British Isles common sense required that there should be much more detail than could be spared for any other part of the Empire. There are thus five or six chapters under different headings in the section on the British Isles, which occupies, if we include the islands in the British seas, more than five-sixths of the first volume, devoted to the topics which in the section on Canada are treated by Prof. Mavor, of Toronto, in three chapters of remarkable excellence under the general heading "Economic Survey."

We have said that the different authors have evidently been left much to themselves in the treatment of the subjects allotted to them. Inevitably this leads to a certain amount of repetition and overlapping, occasionally to the expression of divergent views. Thus it is natural to find Mr. R. D. Oldham, who deals with the physical geography of India, and Mr. J. S. Cotton, editor of the "Imperial Gazetteer of India," who handles Indian agriculture, both take up the subject of Indian soils, and it is distinctly instructive to find that the man of letters is quite confident as to the origin of those soils, while the geologist is not. On matters of more importance such discrepancies are not at all to be regretted. They keep the student in mind of the fact that there are multitudes of questions on which competent authorities trained to inquire into truth for its own sake hold different opinions. Even where there is no actual conflict of opinion it is useful to have different shades of view expressed. Those, for example, who read in the Africa volume Mr. Basil Worsfold's interesting and valuable statement of native problems in South Africa will be able to read them in the light of the observations made by Mr. E. B. Sargant in the chapter on educational problems of the Empire, culminating in the reflection that where there are two distinct social orders, of which one represents largely the hewers of wood and drawers of water, "any neglect of the development of the more backward, group must react unfavourably upon the development of the other, and ultimately leave its mark upon the whole Empire" (General Survey, p. 233), as, on the other hand, those who read these highly general observations will have the advantage of considering them in the light of the more concrete presentments of fact elsewhere.

While there is so much to be thankful for in these volumes there are nevertheless one or two things to regret. To begin with a minor matter, it may be pointed out that some of the maps and diagrams are not so completely self-explanatory as one would like them to be. Thus, in the map of the "Economic Regions of Canada" in the America volume, it is not clear what territory the so-called "Central Agricultural Region" is intended to include. In the map of the "Railways of Eastern Canada," p. 189, there seems to be some mistake in the reference. In the very interesting rainfall diagram on p. 334, as on that of the monthly discharge of the Nile on p. 345, it would be well to add at least the latitudes of the places mentioned. In the former, for example, the contrast between Wadelai and Ghaba Shambe would be all the more striking if we knew that there there is only 4° of latitude between the two places, a fact which there is no means of finding out from the book, inasmuch as Ghaba Shambe is not named on the map of north-east Africa, between pp. 316 and 377.

Then, further, it is both surprising and regrettable that in a work coming out virtually under the auspices of the Oxford School of Geography there should have been apparently so little systematic endeavour to give prominence to geographical influences. Even in the section on the British Isles, a good deal more space is given to the administration of towns than to the conditions that tend to fix their sites and promote their growth. In the Australasia volume there is indeed a deliberate effort to develop those influences in the chapter on physical geography, but this attempt, to our mind, suffers somewhat from the prominence given to geological history in setting forth those influences. The sentences in this chapter may in many cases be individually interesting, but the reading of a paragraph, notwithstanding the illustration by block diagrams, is often hard, that of a sequence of paragraphs still more so.

But there is one chapter conspicuously free from this fault, a chapter by an unnamed writer in which what may be called the geography of British policy and of British strategy is expounded in such illuminating fashion that the most ignorant under this head will be enlightened, a chapter which will be read in present circumstances with the keenest interest, and for the sake of which alone it would be worth while for anyone who has fourteen shillings to spare to buy the volume—that containing the general survey, an admirable volume in other respects. We may conclude this review with a quotation from the chapter (p. 190), which all of us may ponder with profit at the present time:—

> "The geographical situation of the British Isles confers certain advantages from the point of view of waging offensive warfare. It greatly facilitates the protection of our oversea trade against an enemy that is compelled to issue from the North Sea to gain access to the Atlantic, and it enables us to keep the ports on the other side of the Channel under effective observation should necessity to do so arise. But against those advantages must be weighed those conferred by a possible enemy for waging warfare by the double exit from the Baltic *viâ* the Kiel Canal and the Skaggerak. This double exit not only increases the difficulty of maintaining effective observation on any hostile fleet that can make use of either passage, but imposes upon us the necessity of keeping our main fleet in a position from which it can ensure bringing the enemy to action before he can break out of the North Sea, and in certain circumstances might prevent any division of the battle fleet."

G. G. C.

POPULAR NATURAL HISTORY.

(1) *The Courtship of Animals.* By W. P. Pycraft. Pp. xvi+318+40 plates. (London: Hutchinson and Co., 1913.) Price 6*s.* net.

(2) *Hunting the Elephant in Africa and other Recollections of Thirteen Years' Wanderings.* By Captain C. H. Stigand. With an Introduction by Colonel Theodore Roosevelt. Pp. xv+379+plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 10*s.* 6*d.* net.

(3) *Gardens of the Great Mughals.* By C. M. Villiers Stuart. Pp. xviii + 290 + plates. (London: A. and C. Black, 1913.) Price 12*s.* 6*d.* net.

(4) *Ce que j'ai vu chez les bêtes.* By Paul Noël. Preface de G. Colomb. Pp. 343. (Paris: Librairie Armand Colin, 1913.) Price 3.50 francs.

(5) *Cassell's Natural History.* By F. Martin Duncan. Pp. xx + 432 + plates. (London: Cassell and Co., Ltd., 1913.) Price 9*s.* net.

(6) *Animals of the Past: An Account of Some of the Creatures of the Ancient World.* By F. A. Lucas. Pp. xx + 266 + plates. (New York: American Museum of Natural History, 1913.)

(7) *Butterflies and Moths in Romance and Reality.* By W. F. Kirby. Pp. 178 + 28 plates. (London: S.P.C.K., 1913.) Price 5*s.* net.

(8) *Common British Moths.* By A. M. Stewart. Pp. viii + 88 + 15 plates. (London: A. and C. Black, 1913.) Price 1*s.* 6*d.* net.

(1) MR. PYCRAFT has written a very interesting comparative study of the love-making of a great range of animals selected from most of the main zoological groups. The explanation given by Darwin as to the origin of the secondary sexual characters is now, he answers, rather out of date, and Wallace's "arguments for sexual selection are far from convincing and often inconsistent." The "theme" of the book is to show that a sharp line must be drawn between those attributes which are necessary to achieve individual survival and those to achieve the survival of the race-factors which, in the latter, are embraced under sexual selection. Much, Mr. Pycraft believes, hitherto attributed to the action of sexual selection alone—such as the behaviour of animals during sexual activity and the colours they display at this season—is largely governed by the action of "hormones" (the secretions of various ductless glands in the body). "Suggestion" is also necessary, but "suggestion does not suggest" till the hormones have rendered the system inflammable; "suggestion by display" of some kind, as an aphrodisiac, is a necessity, or "how else can desire be indicated? Here is sexual selection." The limits of space assigned to us forbid our discussing this question —which is very interesting, but perhaps less entirely novel than the author realises—beyond mildly "suggesting" that Mr. Pycraft's system seems so saturated by one or more hormones as to "exalt" his particular point of view somewhat at the expense of others. We heartily recommend the book, nevertheless. It contains eighty illustrations on art paper.

(2) Captain Stigand is a well-known African official, devoted to hunting, who always provides his readers with an entertaining, well-written story. The unending stream of books on big-game hunting has, however, now made us fairly intimately acquainted with the lives and artifices of both the hunter and the hunted, so that from this point of view the author's elephant-hunting episodes are less interesting to the general student of nature than the discussion we have in his book upon protective coloration applied to big game. Mr. Roosevelt, in a foreword to the volume, avers, in his usual strenuous language, that the extreme theories of Poulton and Thayer "on this subject" have no bases whatever "in fact," and Mr. Wallace has "strained the recognition-mark theory to an impossible point," but that Captain Stigand's observations now leave "no excuse for further mistakes in the matter." But for the editorial fiat as to space, we are of opinion that it might still be shown that "all is not yet up" with the earlier theories. We can only refer those interested in the subject to the book, to wrestle out the matter for themselves.

(3) Mrs. C. Villiers Stuart's pages form charming memorials of the wonderful old, beflowered, and be-avenued gardens of the Indian emperors, with their warbling fountains and their running waters, so delicious to eye and ear in a parched land. She describes them not only in choice and delicate language, but depicts them in water-colours of great beauty and charm. One of the author's objects, apparently, in writing this book has been to give expression to the hope that in the New Delhi similar gardens may be reproduced. This is a delightful vision; but we greatly fear that the romance that haloes the Mughals and the beauties of their harems, of whom these walled pleasaunces were the shady ambulatory, cannot be revived in our days, and be the gardens of New Delhi never so gay and be-fountained, they will never reproduce those delightful enclosures as they appear to us through the sunlit haze of four hundred years.

(4) We have found the little book by M. Paul Noël, director of the Laboratory of Agricultural Entomology of the Seine-Inférieure, with the quaint title of "Ce que j'ai vu chez les bêtes," very delightful reading. It is written in the very simple, elegant, but exact language for which French scientific writers are so distinguished, and deals with a large number of the common insects, birds, reptiles, and mammals of the country. The author describes and figures several very admirable automatic appliances—for catching insects, rearing larvæ, and other purposes—invented by him in the course of his experiments and observations. Had it not a better use, it would form a very excellent French primer for young nature students.

(5) Mr. F. Duncan's book may be called a digest of the several volumes of the well-known "Cassell's Natural History," by the late Dr. P. Martin Duncan, although to attempt to deal adequately with the whole animal kingdom, as is done here, in a comparatively small volume, is,

we think, an over-bold adventure. The space allotted to many of the phyla is disproportionate to their importance. It is somewhat difficult to form an opinion of the class of reader for whom this book is intended, for we think that neither the general reader interested in natural history, nor the serious zoologist in need of a book of reference, will find it very satisfactory. The volume is well illustrated by 200 photographic reproductions.

(6) Mr. Lucas, the director of the American Museum of Natural History in New York, gives in this volume an account of a number of the most striking prehistoric animals on view in that institution, to the library of handbooks of which it forms a valuable addition. The author's name is sufficient guarantee for the accuracy of its contents; and Mr. Knight's—an artist well known for his skill in depicting prehistoric animals—for the restorations provided in it. Biographical references are appended to each chapter, and there is a sufficient index.

(7) This is a posthumous volume by Mr. W. F. Kirby, well known by his entomological work. As a general account of the lepidoptera the volume will be found accurate, and written in a more than usually interesting style. It is well illustrated by twenty-eight very excellent coloured plates, "made in Germany."

The last volume (8) on our list, one of the "Peeps at Nature" series, dealing only with our common British moths, is more sketchy than Mr. Kirby's. The colour photographs with which it is illustrated are, however, specially good.

ELECTRICAL ENGINEERING.

(1) *Telegraphy.* By the late Sir W. H. Preece and Sir J. Sivewright. Revised and partly re-written by W. L. Preece. Pp. x+422. (London: Longmans, Green and Co., 1914.) Price 7*s.* 6*d.* net.

(2) *Continuous and Alternating Current Machinery.* An Elementary Text-book for use in Technical Schools. By Prof. J. H. Morecroft. Pp. ix+466. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 7*s.* 6*d.* net.

(3) *Laboratory Manual, Direct and Alternating Current.* Prepared to accompany Timbie's "Elements of Electricity." By C. E. Clewell. Pp. vii+100. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 4*s.* 6*d.* net.

(4) *Transmission Line Formulas for Electrical Engineers and Engineering Students.* By H. B. Dwight. Pp. vi+137. (London: Constable and Co., Ltd., 1913.) Price 8*s.* 6*d.* net.

(5) *Wireless Telegraphy.* A Handbook for the Use of Operators and Students. By W. H. Marchant. Pp. xi+241. (London: Whittaker and Co., 1914.) Price 5*s.* net.

(6) *Incandescent Electric Lamps and Their Application.* By Daniel H. Ogley. Pp. x+107. (London: Longmans, Green and Co., 1914.) Price 2*s.* 6*d.* net.

(1) A BOOK based on the immense experience of the late Sir Wm. Preece could scarcely fail to be of the greatest value to telegraphists at large; when, in addition, it has passed through edition after edition for nearly forty years, it is almost superfluous for a reviewer to give either praise or blame. The present edition has been again revised and brought up to date; it has been recast into a larger size of page, which we consider an improvement.

For those who are now beginning their subject we would say that the work aims at describing the simpler methods of land telegraphy, and includes the principles of duplex, quadruplex, and multiplex working, besides the elements of telephone exchange system. There are thoroughly practical chapters on materials and outdoor construction, besides information as to faults and tests. With scarcely an exception, the descriptions are lucid and clear; the literary style is pleasing, padding is absent, and practice lives on every page.

Submarine telegraphy is not included, being regarded as beyond the range of the book. We think it would have been well if wireless had been treated in the same way, as the chapter on this subject (the last one) does not give the reader the same grasp of essentials that the remainder of the book does.

(2) After a careful study of this excellent text-book, any intelligent engineer or engineering student ought to have a good general knowledge of the various kinds of electrical machinery now in use. Although the treatment is of an elementary kind and includes very few formulas, it is very thorough. It discusses all the essential actions in the more important machines very clearly, and includes many useful points which are seldom to be found in text-books. It is somewhat unfortunate that in the preliminary discussions given in the first few chapters the author has chosen entirely to ignore certain facts, and so gives the student a false impression, which he has to correct when the full discussion is reached later on. Thus, the reader to whom the matter is new would probably gather from p. 20 that magnetic hysteresis is the only source of loss in

an armature core; from p. 81 that the correct position for the brushes never depends on the load; and from p. 85 that the heating of a continuous-current armature is the only thing which limits its output.

The book is well illustrated, both by diagrams and half-tone blocks. The latter have mostly been derived from the literature of the large American manufacturing companies, but they have been well chosen; in a few cases only, mostly of instruments, do they show too little detail for the purpose in view. The British reader must, of course, remember that the book is American, and that the statements as to standards and regulations do not necessarily apply to this country.

(3) This book appears to be specially written for use in the author's own laboratory, and we scarcely think it will be of much service elsewhere. It deals with twenty experiments on continuous-current machines and apparatus, and ten on alternating-current ones. It can scarcely be said to describe them, and it certainly does not give those useful practical hints which every laboratory instructor knows to be necessary to enable even the best students to carry out their work successfully. The student is referred to another book for practically everything in the way of information; as we have not seen that book, perhaps it would not be quite fair to criticise this one in detail. But we must confess that except in special circumstances we should never think of using 110-volt mains for measuring the resistance of a yard or two of wire or of the armature of a dynamo, nor of complicating matters by the addition of a short-circuiting switch for every ammeter. On the other hand, we should certainly specify the use of fuses to guard against accident, although the author omits them from his diagrams and instructions.

(4) This excellent little book is a collection of formulas for calculating the voltages and currents at any point in a power transmission line the loads and constants of which are known. It is more a reference book for engineers who have to make such calculations than a text-book for students, but to those of the latter who wish to get up this particular work we can highly commend it. Following an ingenious chart from which the desired results can be read off with sufficient accuracy in the case of short lines, we are given, in tabular form, sets of formulas of increasing degree of accuracy to suit the chief cases which arise. The limits of application are carefully indicated in each case.

Part ii. gives an account of the theory on which these formulas are based; this portion is a model of conciseness combined with lucidity. Part iii. is a repetition of the tables of formulas, with the addition of tables of constants of copper and aluminium cables for the American standard frequencies of 25 and 60 cycles per sec.

(5) This book is non-mathematical and can be thoroughly recommended to those for whom it was written. It gives a very good account of the Marconi system, and also of the various other ones about which the public have lately heard so much. With few exceptions, the descriptions are good and the illustrations are excellent. We should have liked a rather better elementary account of the production of oscillations and of the emission of waves from the oscillator, and also a more convincing explanation of the action of the Marconi magnetic detector. Nor can we imagine any reason for the peculiar connections given on p. 50 for a shunt-wound motor starter.

(6) We wish we could compel all architects, wiring contractors, shopkeepers, and users of electric light generally to read this little book. We might then have fewer glaring (in more ways than one) examples of how not to arrange artificial illumination. The book contains little about the construction of the lamps, but gives an excellent account of their characteristics and of the principles which must be followed if a pleasing result is to be obtained from their use.

DAVID ROBERTSON.

CELESTIAL MECHANICS.

An Introduction to Celestial Mechanics. Second revised edition. By Prof. F. R. Moulton. Pp. xvi+437. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 15*s*. net.

THE appearance of Prof. Moulton's introductory treatise on dynamical astronomy in a second edition is a sufficient proof that the work, which was first published twelve years ago, has satisfied a certain demand. This is very natural, for there is no similar book which covers the same ground. After the revision which it has now undergone it should prove even more useful than in its original form. The author's aim has been to give the student that general view of the whole subject, so far as it can be treated by fairly elementary methods, from which he may pass on, if he pleases to go further, to the technical details which are to be found in treatises on "Bahnbestimmung," or to the refined mathematical processes which are developed in theoretical works on celestial mechanics, or in the original memoirs of the great masters.

The early chapters develop the problem of two bodies in undisturbed motion. They lead up naturally to the problem of determining orbits, which has received a new and admirably clear treatment, and is now placed in its logical order as an illustration of the application of the preceding theory. Even so, the fourth chapter, which deals with attractions, seems to some extent out of place, as it interrupts the study of those parts of the subject which depend essentially on particle dynamics. An interesting chapter on the problem of three bodies leads up to the final section of the book, in which the subject of perturbations is discussed both geometrically and analytically. These two methods will scarcely appeal with equal force to the same class of student.

The book is probably better adapted to the requirements of the American than of the English student. In this country it would be assumed that a reader who was capable of really profiting by the last chapter, for example, must have a considerable mathematical equipment. One would therefore expect a more thorough treatment of some points for which room might be found by omitting some of the more elementary explanations. In America, on the other hand, there is more chance of appealing to some immature but keen student who will be induced to pursue his studies further.

Numerous examples are given, and an index. An excellent feature is to be remarked in the historical and bibliographical notes. With the dictum that Galileo was a man of greater genius than Kepler we are tempted to disagree profoundly; but when genius runs in such distinct moulds, who is to decide? H. C. P.

OUR BOOKSHELF.

The Practice of Navigation and Nautical Astronomy. By Lieut. H. Raper. Twentieth edition. Pp. xxv+934. (London: J. D. Potter, 1914.) n.p.

It is possible to keep the most valuable educational treatise too long before the public; methods grow obsolete with lapse of time and in altered conditions, but later editors, fettered by the spell of tradition, fail to use the pruning knife with sufficient freedom. As a pioneer instructor, seventy-five years ago, Raper's work was admirable. He raised the standard of accuracy, he appreciated the necessity of systematising processes, of shortening calculations, and of ensuring correctness in working. Others occupying the more advanced outposts that he made tenable have improved on his methods, benefited by wider experience, and have aimed at greater efficiency. Of course there is nothing wrong in Raper's book; too many critical eyes have examined its principles, and too many practical hands have tested its usefulness. But accuracy of statement is not all we look for in modern treatises. We expect to find placed at the service of the student all that has been achieved by science, analytical or practical.

Tested by such criteria, the treatise that guided admirably the navigators before the age of steam or of iron and steel built vessels is a little disappointing. In a modern book one would scarcely expect the explanation of Sumner's method of finding a ship's position at sea tucked away in an appendix or limited to a few paragraphs in the text. So far as we can see the student would not suspect that the time-honoured noon sight for latitude, and the morning or afternoon sight for longitude, are but special cases of this most powerful method. The theory of the Sumner Lines of position is so easy to understand, and at the same time is so widely applicable, that it should be made the basis upon which the whole theory of practical navigation depends. Again there is no mention of the desirability of observing time signals sent out by wireless telegraphy, and of the opportunities thus afforded for obtaining accurate Greenwich time. The practical methods suggested by Darwin for deriving improved tidal tables receive but the scantiest mention. These may be slight defects, but we think they indicate the inadvisability of attempting to accommodate an excellent book in its day to the requirements of another generation, possessing enlarged facilities and seeking more scientific instruction.

W. E. P.

Memorabilia Mathematica, or the Philomath's Quotation Book. By Prof. R. E. Moritz. Pp. vii+410. (New York: The Macmillan Co., 1914.) Price 12*s.* 6*d.* net.

Prof. Moritz has brought together more than two thousand passages from the writings of mathematicians, philosophers, and others, and has grouped them under twenty heads, as well as indexed them under nearly seven hundred topics. Among the subjects of the groups of passages which make up the chapters of the book are:—the object, nature, value, and teaching of mathematics; study and research; persons and anecdotes; logic, philosophy, and science in relation to mathematics; arithmetic; algebra; geometry; the calculus and allied topics; concepts of time and space; paradoxes and curiosities. All the passages are in English, having been translated when the original extracts were in other languages. Full references are given, so that the originals can be consulted by the inquiring student when desired.

The preparation of such an extensive collection of notable utterances of some of the world's greatest thinkers must have involved enormous labour; and many writers and teachers will be grateful to the author for providing them with this anthology of mathematical philosophy. The extracts are of varying length and merit, but they are all interesting, and the grouping, as well as the index, enable selections upon particular aspects of mathematical thought and work to be found easily. Passages 907 and 1643, which are given in German from Schiller and Jacobi, as well as in English, appear to be repetitions of the same story in slightly different renderings.

Zur Lehre von den Zuständen der Materie. By Prof. P. P. von Weimarn. Band I.: Text. Pp. x+190. Band II.: Atlas. Tafeln lii. 2 Vols. (Dresden and Leipzig: T. Steinkopff, 1914.) Price 7 marks.

THESE two volumes are put forward in proof of the author's main thesis "that colloid-amorphous properties appear in bodies as their comminution increases, and that such comminution is possible in all bodies." The well-executed atlas of plates reproduces photographs of crystallisation processes in various concentrations, chiefly of barium sulphate and aluminium hydroxide. It is shown that the size of the crystals is strongly influenced either way by the concentration. Examined in the ultra-microscope, jellies and transparent colloid structures generally show minute particles which are essentially crystalline, differing from crystals only in their size. Any solid, sufficiently comminuted, might be made into a "solid mist" of particles showing Brownian motions, but the latter are just what leads as a rule to crystalline agglomeration. By comminuting aniline-blue into a neutral substance (urea), Pihlblad obtained colloid solutions of the former in water of any degree of fineness. The author, in view of these facts, proposes to substitute the term "dispersoid" for the less significant term "colloid," and would call the science of colloids "dispersoidology."

PROBLEMS OF THE PENGUINERY.[1]

DR. LEVICK has made a fascinating study of the Adélie penguins (*Pygoscelis adeliae*), and the charm of his book is enhanced by his beautiful and really interesting photographs. He has certainly a good subject, for penguins are among the quaintest of living creatures, among the most ancient of birds, triumphs of adaptation to aquatic life, remarkably congruent with Antarctic conditions, and very instructive from a psychological and even sociological point of view. Inquisitive, unafraid, altruistic and social, they make a strong claim on our interest and sympathy.

The Adélie penguins spend their summer and bring forth their young in the far South. They seek out wind-swept places, kept bare of snow, where they find solid ground and pebbles for making nests. After the chicks have been sufficiently educated to be able to fend for themselves, young and old leave the southern limits of the sea and make their way to the pack-ice out to the northward. The first year's birds remain on the pack for two winters, until they get their adult plumage. "The spring following this, and probably every spring for the rest of their lives, they return south to breed, performing their journey, very often, not only by water, but on foot across many miles of frozen sea." That they find the breeding ground is remarkable, for they cannot see far when they are swimming (and there is often nothing to be seen), or when they are "tobogganing," and their horizon when walking

"Occasionally an unaccountable 'broodiness' seemed to take possession of the Penguins." From "Antarctic Penguins."

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[1] "Antarctic Penguins." By Dr. G. Murray Levick. Pp. x+140+ plates. (London: W. Heinemann, 1914.) Price 6s. net.

is only one mile distant. Dr. Levick believes that they have a special sense of direction.

At Cape Adare the penguins returned from the sea about the middle of October; they were at first fatigued and sleepy but soon began to pair and nest. Dr. Levick describes the combats of the cocks, who strike one another doughtily (with one flipper at a time, but ambidextrously); the gentleness and patience of the combatants in their overtures to their desired mates, who make some show of reluctance and have a tendency to hen-peck; the ecstatic attitude assumed at times by either sex, with an associated *chant de satisfaction* which seems to arouse the other partner to come to soothe the first; the activity of the cocks in gathering stones for the nest, often stealing them (a preference for bright colours was noticed); and the individual differences in character, for there are vigilant and unwary, tough and timorous birds. A very remarkable fact is that they do not eat anything all the time!

The fast may be prolonged for twenty-seven days of strenuous life. Thirst is quenched with snow, and on rare occasions the cock may bring a lump to the nesting hen. Incubation seems to last for rather more than a month, the female taking the first fortnight while the male goes off to recuperate; towards the end of the period the parent birds go to the sea in turn, feeding greedily on the abundant Euphausid crustaceans. The developing eggs have to be protected from the cold and from the intrusive skuas. "Evidence goes to show that the sea-leopard is the only living enemy, excepting man, that threatens the life of the adult Adélie penguin." Dr. Levick gives a delightful account of the habits of the penguins in the water and of their games. But there are two points of even greater interest. As the chicks become bigger and their appetites likewise, the turn-about method of securing food is inadequate. "The individual care of the chicks by their parents is abandoned, and in place of this colonies start to 'pool' their offspring, which are herded together into clumps or *crèches*, each of which is guarded by a few old birds, the rest being free to go and forage." The guardians of the *crèche* protect the chicks from the skuas and from the not less troublesome "hooligan" cocks (apparently idle bachelors and wicked widowers). Also suggestive of social development was an extraordinary occurrence witnessed by Dr. Levick and Mr. Priestley, a congregating of penguins into massed bands some thousands strong and an apparent drilling! From one of the motionless bands a single bird ran out in the direction of another band, and stopped. In a flash the entire band from which he came executed the movement "left turn." The band which he had approached did the same, and the two bands marched straight towards one another, and joined to form one body. Similar procedure continued for many hours. Dr. Levick's suggestion is that the "drilling" is a reminiscence of "massing" before migration, going back perhaps to flying days! We have to congratulate the author on his well-told story.

THE PROTECTIVE TREATMENT AGAINST TYPHOID FEVER.

TYPHOID fever is inseparable from war. It finds in war, ready for it, all that it could desire. In times of peace we have a thousand ways of avoiding it, a thousand ways of holding it up: so sure are our defences, so elaborate our plans, that we get into a stupid way of thinking of typhoid fever as if it were due only to "insanitary surroundings"; as if it were a disease altogether unlikely to show itself within ten miles of a good medical health officer. Then comes war; and, with declaration of war, comes the general mobilisation of the infective diseases. They are called up, they are sent to the front. Louvain as it was and Louvain as it is are scarcely more unlike than are typhoid in times of peace and typhoid in time of war.

For sheer inaccuracy it would be difficult to surpass a paragraph lately published in a little journal which bears a medical name, but certainly does not in this matter represent either medical opinion or public opinion. This journal "objects *in toto* to serum inoculation as a method of dealing with typhoid." We can measure the wisdom of the little journal, here, by the fact that the protective treatment against typhoid is not a serum-treatment, and has nothing to do with any sort or kind of serum. Then the journal says: "In the parts of France where our troops are operating there should be no difficulty with regard to hygiene. The troops are not shut up in a city closely invested and living on famine rations, but are constantly on the move in a land flowing 'with milk and honey,' not to mention rivers of grape juice, which is, if rationally used, Nature's own 'anti-typhoid serum.'" It says that; it really does. And one of the "anti-vivisection" societies has published an advertisement saying that the protective treatment "leads to tuberculosis"!

Typhoid is, of course, already taking part in the present war. Given the Allied Armies and the German Army in the Western Theatre, how should there not be typhoid? The only question is, How much more will there be a month hence? The lateness of the year, happily, will kill off flies, which are great carriers of the disease; but the flies are not yet gone, and they will more or less repeat that deadly part which they took in the South African War. There is plenty of the disease for them to carry. "It is well known," says Sir Almroth Wright, in the *Times*, September 28, "that the infection of typhoid is thickly sown all along the frontier of France and Germany." Besides, among two millions of men, there are bound to be some who have the germs of the disease in them. And what is the good of talking of "sanitation," as if our men could have the warm baths and the water-closets of the average Englishman's home? Let us take Dr. Johnson's advice, and clear our minds of cant. "An army," as Wright says, "on going out on active service goes from the sanitary conditions of civilisation straight back to those of barbarism. . . . In war the doors are everywhere opened wide, both to the direct conveyance of infection by the excreta, and to its indirect conveyance by means of contaminated water. . . . On service, proper sanitary arrangements are very often impossible. We may think, for instance, of the situation of men in the trenches under fire. . . . When it comes to a tight place the alternative which will present itself will be that of drinking a polluted water or none. . . . It will, by the very nature of the case, be out of question to apply ordinary sanitary measures in an effective manner. . . . Infection spreads not only among the troops in the field, but also among the soldiers in hospital."

The *Daily Chronicle*, October 3, says, "It is reported that 800 Germans, on the lines between Brussels and Antwerp, are suffering from typhoid fever."

That the protective treatment is indeed protective we all know. It is the experience of the nations of the earth; and the whole world is agreed about it. France, India, Canada, the United States, Italy—let alone our enemies—are of one mind. Take only four instances:—

1. *British Army in India.*—"The histories, as regards typhoid fever, of 19,314 soldiers, whose average period of service abroad was twenty months, were carefully followed, and every precaution possible was taken to verify the diagnosis bacteriologically. Of this number 10,378 were inoculated, and 8936 not inoculated. The case incidence of typhoid fever among the inoculated was 5·39 per 1000, and among the non-inoculated 30·4 per 1000."—*Report of Anti-Typhoid Committee*, 1912.

2. *United States Army.*—"Inoculation was made compulsory in the American Army in 1911, and has practically abolished the disease. In 1913 there were only three cases and no deaths in the entire army of over 90,000 men."—Sir W. Leishman, *Brit. Med. Journ.*, August 22, 1914.

3. *French Army.*—In 1912 typhoid broke out in the barracks at Avignon. Of 2053 men, 1366 were protected and 687 were not. The non-protected had 155 cases, with twenty-one deaths; the protected had not one case. The protective treatment was made compulsory last winter in the French Army; and, in special circumstances, among the reservists.—*Lancet*, January 4, 1913.

4. *Canadian-Pacific Railway.*—Throughout the "railway camps" in Alberta, during 1911, among 5500 protected there were only two cases of typhoid; among 4500 non-protected there were 220 cases.—*Brit. Med. Journ.*, June 6, 1914.

It remains to be noted: (1) That the vaccine contains no living germs of any sort. (2) That the treatment, though it gave good results in the South African War, has been improved since that time. (3) That the avoidance of exertion and excitement, on the day of treatment, is a great safeguard against any disturbance of the general health. (4) That, when time allows, it is always best to give the vaccine not all in one dose, but in two, or even three graduated doses, with a few days between each dose.

Sir Almroth Wright, by whose hands the gift of this treatment came to us, greatly desires that the treatment should be made compulsory, as in other armies, so in ours. Surely it is part of "my duty to my neighbour" that I should not, by having typhoid, expose him to the risk of infection from me. And it is certain that a soldier down with typhoid fever is not only useless against the enemy, but dangerous to his own friends.

Stephen Paget.

THE BRITISH ASSOCIATION IN VICTORIA.

Melbourne, August 20.

On their arrival from Adelaide by three special trains on Thursday, August 13, the visitors were taken to their quarters, but soon most of them found their way to the reception room at the University. The lecture theatres of the University, and of the Teachers Training College, afforded ample accommodation for all the sections, and are in the same grounds.

In the evening the Governor-General received members at Government House, and some 3000 guests were present at a brilliant function. On Friday afternoon, August 14, a graduation ceremony was held in Melba Hall, when nearly 1000 persons were present. The degree of D.Sc. was conferred on the president, Prof. W. Bateson, and on Sir Edward Schäfer, Prof. H. E. Armstrong, Dr. F. W. Dyson, Sir Thomas Holland, Prof. W. J. Pope, Prof. A. W. Porter, Sir Ernest Rutherford, Prof. Johannes Walther, Prof. W. M. Davies, Prof. C. G. Abbott, and Prof. Luigi Luiggi. At a later hour the Lord Mayor held a reception at the Town Hall, which was largely attended. In the evening the president delivered the first half of his address in the auditorium in the presence of more than 2000 persons. The Governor-General and the State Governor were present, and proposed and seconded the vote of thanks.

On Monday afternoon, August 17, Prof. E. B. Poulton delivered a discourse on "Mimicry" before a very large and appreciative audience. In the evening the Government of Victoria held a reception at the Public Library, Picture Gallery, and National Museum, the buildings for which are in communication. The guests, numbering about 4000, were received by the Premier, Sir Alexander Peacock, Lady Peacock, and by the Chief Secretary, the Hon. John Murray. The ample accommodation afforded by the large rooms prevented undue crowding, and the evening was most enjoyable.

On the following afternoon the Overseas members were entertained at the Botanic Gardens by the members of the scientific societies of Victoria. The weather was delightful, and the magnificent gardens were greatly admired by the guests. The president planted a memorial tree (*Cupressus macrocarpus*) to commemorate the historic visit of the association. In the evening

Dr. F. W. Dyson delivered the second discourse on "Greenwich Observatory and its Work."

A number of week-end excursions were made, and, owing largely to the beautiful, though unseasonable, weather, were all successful. The greater number of the excursionists were Overseas members, the Australian members being restricted largely to the official leaders and experts in what may be called "side-issues." Thus, a geological excursion would be accompanied by someone who could name plants, and so on.

About forty went by special train to Bacchus Marsh to inspect the Permo-Carboniferous glacials. Drs. Hall and Pritchard were the leaders, and Messrs. Sweet and Brittlebank, who discovered and worked out the beds, were present to help, and the main features were clearly seen.

The Surveyor-General, Mr. J. M. Reed, led a party by train and by coach over the dacite mountains to Marysville. Botanists, zoologists, and sightseers had a splendid, though somewhat arduous, time. Dr. C. S. Sutton and Mr. James Cuming, who was the host for the occasion, took a very large number by train to Warburton and Cement Creek. This is the home of big trees, though most of the giants have vanished. A visit was paid to the works of Messrs. Cuming, Smith and Co., where a number of chemical products from the eucalyptus are prepared on a fairly large scale. The naturalists revelled in the rich fern gullies with their wealth of zoological and botanical novelties.

A long day's excursion to the Macedon district was made possible by the generosity of the Automobile Club of Victoria, which provided cars. Prof. Skeats and Dr. Summers were the leaders, and the remarkable series of igneous rocks, for which the locality is famous, were well explored.

Prof. A. J. Ewart and Mr. R. Grimwade took a very large party by train along the narrow gauge track to Emerald. The mountain forest country was seen and large nurseries for raising fruit trees, and the Bosisto experimental oil-farm were visited. At the latter place, Messrs. Grimwade and Co. are cultivating scent plants, and have large experimental plantations of eucalyptus. Botanically, the excursion was a great success, as many typical Australian plants were seen.

A large party went by special train to Ballarat, the second city of the State. The mayors of the twin cities were most hospitable, and Mr. Wm. Baragwanath, the geological surveyor in charge of the district, demonstrated the leading features. The Government geologist, Mr. H. Herman, took another large party to Bendigo, where the famous "saddle" reefs were the chief source of attraction. The structure of the field was very clearly seen, and the lavish hospitality of the mayor and of the leading citizens was highly appreciated. Both here and at Ballarat, the plentiful loan of motor-cars made the inspection of wide areas of the surrounding country possible.

An excursion to the National Park at Wilson's Promontory, where 150 square miles of mountainous country is reserved as a sanctuary for animals and plants, had been planned by steamer. Almost at the last moment, the war troubles prevented the loan of the vessel. However, Mr. C. Catani, chief engineer of the Public Works Department, the leader, and especially Mr. J. A. Kershaw, curator of the National Museum, managed an overland transport, and the visit was thoroughly enjoyed by the small number who went.

Visits were paid to the Central Research Farm at Werribee under Dr. S. S. Cameron, Director of Agriculture, and to the Bacchus Marsh irrigated area under Dr. Elwood Mead.

Besides these official excursions, a large number were made under private guidance, and many special entertainments were given.

The meeting was, from all points, most successful; the Victorian members numbered 1998, and the details of organisation were under the control of Prof. Baldwin Spencer.

T. S. HALL.

NOTES.

THE Research Defence Society has prepared an instructive leaflet upon the subject of protection against typhoid fever, dealt with by the honorary secretary of the society, Mr. Stephen Paget, elsewhere in the present issue of NATURE. The society sends out supplies of this leaflet, and makes arrangements for providing the treatment, free of charge. Application should be made to the hon. secretary, Research Defence Society, 21 Ladbroke Square, London, W.

IT is reported by a Reuter message from Smyrna that an earthquake which occurred at midnight on Saturday, October 3, partly destroyed the towns of Isbarta and Burdur in the province of Konia, Asia Minor.

THE death occurred on September 30, at eighty-eight years of age, of Sir Henry Littlejohn, late president of the Royal College of Surgeons, Edinburgh, professor of forensic medicine in the University of Edinburgh in the years 1897–1906, medical officer of health for Edinburgh from 1862 to 1908, and the author of many publications on legal medicine and public health.

THE attention of our readers may be usefully directed to the joint propaganda of the Fisheries Organisation Society and the National Deep Sea Protection Association. These bodies have issued a reprint of an article, by Mr. Stephen Reynolds, on fish-food in wartime, and a series of very practical recipes and hints on cooking and buying fish, in which particular attention is directed to the use of cured herrings and other fish. The Board of Agriculture and Fisheries also issue leaflets relating to the further utilisation of fish and salted herrings as food. It is very desirable that the propagandist efforts to which we refer should be made as widely known as possible. Deep-sea fishing is suffering severely from the restriction of the fishing grounds, from actual war losses, and from the diversion of very many vessels and men to the dangerous task of mine-sweeping; and with very great loyalty the fishing trade in general has combined to keep prices as low as possible. The herring fisheries are suffering even more severely from the loss of their great continental markets for salted fish: it will be unfortunate in every way if the yield of this industry should be gravely diminished, and the only hope seems to be in the securing of the normal stock of pickled herrings for domestic use and future trade, by the State. The Fisheries Organisation Society is an outcome of the recently published report of the Inshore Fisheries Committee: it aims at the further development of the smaller sea and coastal fisheries by various methods. Its offices are at Queen Anne's Chambers, Tothill Street, Westminster. At no other time than the present could this organisation be of greater service to the country, and we hope that many of our readers may be inclined to make themselves acquainted with its work.

We have received from Mr. Francis Edwards, of 83 High Street, Marylebone, W., a catalogue of "books about birds," together with a certain number of publications of learned societies, the whole comprising between two and three hundred items.

According to the *Victorian Naturalist* for August, an attempt is to be made to introduce the lyre-bird into Tasmania. Mr. D. le Souëf, who was consulted in regard to the probable cost of the experiment, gave the opinion that the birds could be trapped for about 5*l*. per pair, adding that suitable food during the period of confinement could be supplied by the Melbourne Zoological Gardens.

Free-swimming nematode and littoral oligochæte worms from the salt Chilka Lake, on the Orissa coast of Bengal, form the subject of two articles, respectively by Dr. F. H. Stewart and Major J. Stephenson, in vol. x., part 4, of Records of the Indian Museum. All the four genera of the former group found in the lake-fauna are cosmopolitan, and for the most part marine types; but at least four of the Chilka species, referable to three genera, are regarded as new.

In vol. ii., No. 5, of the *Austral Avian Record*, the editor, Mr. G. M. Mathews, makes further emendations in his list of Australian birds. Among these may be noted the creation of no fewer than a dozen new generic names for various long-established species. To many naturalists this will seem an altogether unnecessary proceeding, and, in any case, such inelegant and unwieldy compounds as Purnellornis, Alphachlamydera, Alphacincla, and the like, are to be deprecated.

To the October number of the *Museums Journal* Dr. F. A. Bather contributes an instructive article on museums and national service, in which special reference is made to the various branches of research work now carried on at the Natural History Branch of the British Museum. The amount of work of direct practical utility yearly accomplished there would, it is claimed, surprise even those familiar with that establishment, attention being also directed to the cosmopolitan character of these researches. At present the museum has not a health department, with special facilities for bacteriological work and the practical study of hygiene; but it is suggested that such an addition would form an important extension of the museum's already manifold functions.

In connection with the above, reference may be made to an article in the same issue by Mr. F. Leney, of the Norwich Museum, on the insurance of museums and their contents against fire and damage from other causes. The article formed the subject of a paper read at the recent Museum Conference at Swansea, where an instructive discussion took place at the close of the reading. Metropolitan Government museums are, we believe, uninsured, and the matter relates, therefore, solely to local institutions. The usual practice, it appears, is to insure the buildings separately from the collections, and generally against fire alone. Loan collections are, however, habitually insured against risks of all kinds. In the discussion, Dr. Hoyle referred to the progressive appreciation in value of many objects in museums, and the consequent automatic under-insurance of collections.

Bird-skins in museums, it appears, form a rich hunting-ground for students of bird-lice (Mallophaga), as those parasites are generally preserved with the skins of the birds they infest. Advantage of this has recently been taken in the Indian Museum, Calcutta, where the store-skins of game-birds and the crow-tribe have been carefully searched, and the dried parasites picked out. The latter were sent to Prof. V. L. Kellog, of Stanford University, California, by whom and his colleague, Mr. J. H. Paine, the collection is described in vol. x., part 4, of Records of the Indian Museum. That the bird-lice found in any individual kind of bird-skin are really native to that particular species, appears, in most cases at any rate, to be beyond doubt, and, as the result of their study of the Calcutta collection, the authors of the paper have felt themselves justified in describing no fewer than thirteen species as new.

The subject of "glazed frost" is always interesting, owing to its somewhat rare occurrence, and possibly to some extent to the uncertainty of part of the physical process involved in its formation. The term is now generally adopted for the smooth coating of ice which covers objects, and is usually formed when rain, consisting of super-cooled water drops, strikes the ground or other objects, but may "very occasionally" be formed in other ways. To the Journal of the Meteorological Society of Japan for May last Dr. T. Okada contributes some useful notes on the phenomenon, and quotes cases of its occurrence in that country, together with detailed observations. His calculation shows that, in the case under consideration, "the conduction and evaporation of raindrops falling through ice-cold layers of the atmosphere will be sufficient to cool them many degrees below the freezing point." As pointed out elsewhere by Mr. E. Gold, the difficulty appears to be to explain why small drops do not solidify in falling through the air.

In the *Mathematical Gazette* for July (vi., 12), Prof. Harold Hilton proves that any twisted cubic curve may be displaced so that every point is moving perpendicular to its tangent, provided that the curve is screwed about a certain fixed axis.

The resistance of road vehicles to traction is commonly regarded as the sum of two parts, one due to rolling friction on the ground and the other due to sliding friction at the axle. In a recent note (Venice, Carlo Ferrari, 1914) reprinted from the *Atti del R. Istituto veneto*, lxxiii. (2), pp. 931–46, Prof. T. Levi Civita, by considering the conditions of equilibrium, establishes the interdependence of these two resistances, and obtains new formulæ determining the total resistance. The title of the paper is "Sforze di regime e sforze d'avviamento per veicoli trainati."

From the Department of Lands and Surveys of Western Australia we have received a copy of its "Geodetic Tables." This publication contains two tables, of which one gives the logarithms of the number of links in 1″ of latitude, and of longitude, and the other gives the logarithms of the seconds of the arc-versines of spheroidal arcs of parallels 1″ in length. In each case the tables cover the range of 50° from the equator southwards. The tables are based on the auxiliary tables of the Survey of India, the values for the additional ten degrees having been specially computed. A short introduction explains the method of using them, and they should be of use to land surveyors who wish to control their work by means of the triangulation stations of the department.

It was proved by Prof. Arnold Emch in the *American Journal of Mathematics* for October, 1913, that in every closed convex curve which is analytic throughout, at least one square can be inscribed. That at least one square can be circumscribed about such an oval curve is now proved by Prof. Tsuruichi Hayashi in the Bulletin of the American Mathematical Society, xx., 9, where he also obtains a parametric representation of the curve in tangential co-ordinates. His proof of the possibility of circumscribing the square about an oval curve is very simple. You can evidently circumscribe a rectangle having its sides parallel to any given direction. Now turn the direction round until the longer side becomes the shorter one. Then in some intermediate position the two sides will become equal, and the figure is then a square. It will be interesting and easy for mathematically inclined readers of Nature to reconstruct from this material a corresponding proof for the inscribed square if they have not seen Prof. Emch's paper.

In Yamagata, Japan, is a small lake called the Lake of the Floating Islands, discovered about the year 1340, which has from that time attracted the attention of many poets and literary men. A report on the mysterious movements of these islands drawn up by a party under Prof. S. Kusakabe is published in the Science Reports of the Tohoku Imperial University (Sendai), iii., 2. The floating islands, which at times number no fewer than sixty, are found to be continually changing their position, moving first one way and then the other. In the first series of observations, wooden floats were placed in the lake showing the distribution of the various currents; subsequently a model of the lake was constructed, and it was found possible closely to reproduce the various movements of the surface. When both water and wind currents were taken into account, the actual behaviour of the islands was found to be quite in accordance with theory and experiment. The islands originate from masses of vegetable *débris* which are first carried to the surface by bubbles of gas; then reeds commence to grow from seed on them; sometimes the mass becomes top-heavy and overturns, and reeds grow on the other side, until the island has grown sufficiently large in extent to secure stability.

The September number of *Terrestrial Magnetism and Atmospheric Electricity* contains reports of the work done by the magnetic survey ship *Carnegie* during her second cruise round the world and during a more recent journey from New York along the Gulf Stream to Hammerfest. Along the line of the latter route the values of the deviation of the compass to the west of true north were found to be in general greater than the values given in the British and American charts by amounts which reach 1·3° in the former and 2·2° in the latter chart. The atmospheric electric observations taken during the voyage round the world lead to the conclusion that over the sea the potential gradient is of the same order as that over land, the radio-activity is smaller, while the specific conductivity is larger, than that over land. The conductivity appears to be independent of the radio-activity, although, like the radio-activity, it is greater for air which has been in contact with land than for air which has not during the week before the observations on it are made.

The Journal of the Washington Academy of Sciences for August 19 contains two interesting optical papers. The first, by Prof. P. G. Nutting, of the Eastman Research Laboratory, gives the results of a series of measurements of the focal length of the human eye for light of different wave-lengths within the visible spectrum. The author finds that while for a water lens the focal length increases by about 5 per cent. from the extreme blue to the red end of the spectrum at a rate which is fairly uniform, for many human eyes the increase, although of about the same amount, is confined to the ends of the range, the change over the middle half not exceeding 1 per cent., so that these eyes are nearly achromatic. The second, by Mr. F. E. Wright, of the Geophysical Laboratory, describes a new method of determining the refractive index of a mineral by the petrographic microscope. A stop below the condenser covers half the field, and its inverted image is formed between the stage and the low-power objective. In the same plane as this image a second stop is placed, and the distance of the edge of the second from that of the image of the first so adjusted that the field is nearly dark. In these circumstances, if a grain of mineral immersed in a liquid of refractive index not exactly equal with that of the mineral is placed on the microscope stage, the edges of the grain appear some brighter, some darker, than the field, and a liquid having the same refractive index as the mineral can be quickly chosen.

PRACTICAL methods of determining the critical loads for long struts of varying section have attracted some attention recently. The latest contribution to the subject is given in an article in *Engineering* for October 2 by Messrs. L. Bairstow and E. W. Stedman, of the National Physical Laboratory. The method described seems to be comparatively easy to apply, and has the advantage of being applicable with equal ease to the simplest or to the most general case. It was devised originally for finding the critical loads of wooden struts as used in aeroplane construction. An assumed critical load for the strut is guessed or obtained by an approximate method such as taking Euler's law for a uniform strut of the average section. Curves for $-d^2y/dx^2$, dy/dx and y, which comply with the conditions imposed, are then drawn by a process of trial and error described in the article. If the assumed value of the critical load has happened to be correct, the ordinate of the dy/dx curve becomes zero at the middle of the strut (for a strut hinged at both ends). If the assumed value has been incorrect, the ordinate becomes zero at some other point. After two attempts, a very close approximation to the value of the critical load is reached.

ERRATUM.—In NATURE of September 24, p. 95, col. i., for Dr. S. N. Shannus read Dr. H. S. Stannus.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—The *Times* of October 3 publishes a telegram from South Africa announcing the discovery of a bright comet by Mr. Lunt at the Royal Observatory, Cape Town, on September 18. Mr. Wood, of Johannesburg, computed the orbit, and the following is the ephemeris given:—

	Right Ascension h. m. s.	Declination ° ′
Oct. 1	22 48 48	−26 44
5	22 23 36	17 41
9	22 8 44	11 11
13	21 59 24	−6 34

Perihelion passage took place on August 5. While the comet is decreasing its southern declination and reaching a better position for observation in this country its brightness is stated to be fading fairly rapidly owing to the increasing distance from the sun. On October 9 the comet will be situated in the constellation of Aquarius, a little below the third magnitude star gamma.

The following elements, based by Mr. Wood on observations made on September 21, 24, and 27, have been since communicated by the Royal Astronomical Society:—

$$T = 1914 \text{ Aug. } 4{\cdot}99 \text{ G.M.T.}$$

$$\left.\begin{array}{l}\omega = 270^\circ\ 19' \\ \Omega = 0^\circ\ 22' \\ i = 77^\circ\ 51'\end{array}\right\} 1914{\cdot}0$$

$$\log q = 9{\cdot}8543$$

COMET 1913*f* (DELAVAN).—Delavan's comet is now badly situated for evening observation, so most should be made of the morning hours. The object is rapidly decreasing its northern declination and moving westward, and will pass perihelion on October 26. It is now situated in the constellation of Canes Venatici, and on October 10 will not be far from the third magnitude star, 12 Canes Venaticorum. The following eight-day ephemeris is taken from *Knowledge* for August last:—

	Right Ascension h. m. s.	Declination ° ′
Oct. 10	12 56 44	+38 56
18	13 37 56	32 57
26	14 11 50	26 45
Nov. 3	14 40 44	+20 40

THE RETURN OF ENCKE'S COMET.—The short-period comet known as Encke's comet, for he it was who first calculated its elements, although Pons, of Marseilles, actually discovered it in the sky, was due to return this autumn, its period being about three and one-third years. It is now reported (*Daily Telegraph*, October 2) that it has been observed from the Russian Observatory at Simeis in the Crimea, this information having been received from Prof. Backlund, the director of the Pulkovo Observatory. It is situated in the constellation of Perseus. Encke's comet is of historical interest for several reasons. It was only the second instance of the recognised return of a comet, Halley's comet having preceded it by sixty-three years. It was also the first example of a new class of celestial objects revolving round the sun within the orbit of Saturn and exhibiting certain planetary affinities in the manner of their motions.

ENHANCED LINES AND THE PRESENCE OF HYDROGEN.—No. 85 of the Contributions from the Mount Wilson Solar Observatory is devoted to some electric furnace experiments on the emission of enhanced lines in a hydrogen atmosphere. The author, Mr. A. S. King, used in this research the vertical Rowland grating spectrograph described in this column on September 24. The experiments included the production of the enhanced lines with the furnace in a partial vacuum and in hydrogen at varying pressures up to one atmosphere, and the use of greatly different amounts of titanium. After describing the details of the experiments Mr. King sums up his results in three brief but interesting paragraphs. The experiments failed to show any effect of a hydrogen atmosphere in strengthening enhanced lines. The enhanced lines appear in the furnace at low pressures with equal ease whether hydrogen is present or whether the furnace contains a residue of air. No material effect on the relative intensities of enhanced lines is indicated, even when widely differing amounts of titanium vapour at low pressure and at the same temperature are employed. Increasing the pressure of hydrogen, the temperature being held as nearly constant as possible, causes a progressive weakening of the titanium enhanced lines, until at atmospheric pressure only traces of the strongest are visible in the furnace spectrum. Mr. King finally directs attention to the bearing of these results on the study of stellar atmospheres and the value of the strength of enhanced lines as a criterion not only for stellar temperatures but for different regions and levels of the solar photosphere.

THE LEEDS ASTRONOMICAL SOCIETY.—Vol. xxi. of the Leeds Astronomical Society contains the Journal and Transactions for the past year. The volume is edited by Mr. C. T. Whitmell, and gives a good account of the activity of this society. At each of the seven meetings which took place a paper on some definite subject was read, and these are reproduced more or less in full in this report. Thus some of the contributions dealt with the spectroscope, Uranus as a view-point, history of astronomy, etc. Other work of the society is summed up in the latter part of the volume.

GEOLOGY IN BRITISH AFRICA.

MEMOIR No. 6 of the Geological Survey of South Africa, by A. L. Hall, on "The Geology of the Murchison Range and District," deals with picturesque features of the Drakensberg scarp. Plate xv. finely illustrates the youthful nature of the Groot Letaba River (Fig. 1), which is represented (p. 29) as having cut back into the mature drainage-system of the M'Thlapitsi. The banded ironstones near Thabina (p. 66), associated with metamorphosed sediments, are regarded as also of sedimentary origin, although they are now composed of magnetite. We believe that this view must be generally accepted, and it has an obvious bearing on theories of the origin of the sheet-like magnetite ores of Sweden. Pp. 124 to 130 contain an interesting account of the formation of hybrid rocks between syenite, pyroxenite, and limestone. The limestone now contains olivine, magnetite, and apatite. The Olifants River mica-fields come within the scope of this memoir (p. 153). We notice (p. 19) that "neck" is used, perhaps unwisely, in its English form for a notch produced by weathering.

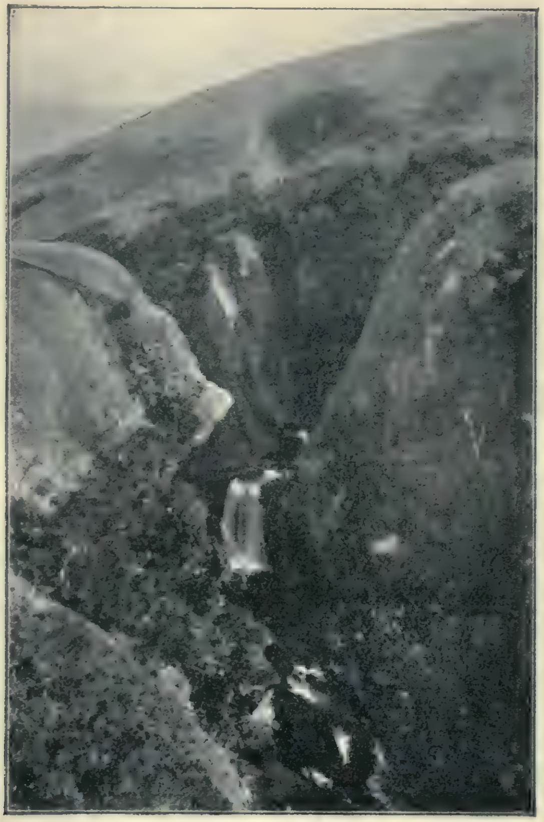

FIG. 1.—Gorge cut by the Groot Letaba River in its recession from the escarpment; the stream now receives water captured from the M'Thlapitsi.

Sheet 13 of the geological map, and the accompanying memoir on "The Geology of the Haenertsberg Goldfields" (1914), are concerned with similar country, and the great scarp of the Black Reef quartzite appears conspicuously on the map. The memoir and map (Sheet 12) of the Pilandsberg, a great igneous centre north of the Witwatersrand and Rustenburg, are due to W. A. Humphrey, and direct attention to a region of great petrographic interest. The rocks have been previously described; they are syenites rich in alkalies, forming a great wall-like ring that surrounds a region of tuffs and lavas, also of the alkali type. Aegirine, leucite, and nepheline occur in the volcanic rocks. The ring suggests a "cauldron-subsidence," and an oozing up of matter along the marginal crack, as described by E. B. Bailey in the Cruachan area. The circular group of rocks is shown to be later than the Waterberg system, but has no kinship with the Drakensberg outflows. The map of this basal relic, sixteen miles across, forms one of the most striking lessons in volcanic structure with which we are acquainted.

The annual report of the Geological Survey of South Africa for 1912, published at the close of 1913, contains a summary by the director, H. Kynaston, both in Dutch and English, a memoir by him on the Marico and Rustenburg districts, one on the western Witwatersrand by E. T. Mellor, and a finely illustrated memoir by A. T. Hall on the country between Belfast and Middelburg. A. L. du Toit reports on Pondoland.

It is difficult in a few notes to do justice to the large amount of mineral and petrographic information issued regularly in the Transactions of the Geological Society of South Africa. In vol. xiv. (1912) p. 71, G. S. Corstorphine records a further occurrence of diamond in eclogite from the kimberlite pipe of the Roberts Victor Mine, Orange Free State. He still maintains that such eclogites are segregations from the peridotite (kimberlite) magma. C. T. Mellor (p. 99) contributes a detailed revision of the Lower Witwatersrand system, with a map and sections. He concludes that the conglomerates indicate a steady progression from deposits on the seaward margin of a delta up to true beaches on a shore. In vol. xv., p. 31, A. W. Rogers publishes his correlation of the Nieuwerust, Malmesbury, and Ibiquas Series of the Cape Province with the Nama system of German South-West Africa. The three series are now shown to have the sequence given above, the Nieuwerust beds being the oldest. P. Range's paper (p. 63) on the topography and geology of the German South Kalahari contains an interesting account of the nature of "pans." The author points out that good supplies of water are within reach of the dry lands of the Kalahari, in the Karroo and Nama beds that underlie the calcareous sandstone and dune-sand of the surface.

The Proceedings of the society include a lengthy discussion of Mr. Mellor's stratigraphical paper, and a presidential address by R. B. Young on the problem of the Rand Banket (1911, p. xxi.). Dr. Young argues against the detrital origin of the auriferous pyrite in the conglomerates. In vol. xv. (p. 83) he urges that the black colour of the quartz in the banket is due to dark inclusions, and he shows by thin sections how these are commonly related to shattered areas in the pebbles. The colour, then, arose after the vein-quartz had become included in the conglomerate.

Prof. Schwarz (*ibid.*, vol. xvi., 1913, p. 33) revives interest in the contacts of granite and schist near Cape Town, which were described by Playfair and Basil Hall in 1813, and by Clarke Abel in 1818. He does not mention Darwin's fruitful observations; but he accepts the view that the granite has absorbed the slates, and that the parallel flakes of biotitic matter represent residues from the sedimentary series. The advance of the granitic matter into the slate has allowed of the development (p. 35) of felspar crystals 2 in. long as replacements of digested matter. F. E. Studt provides (p. 41) an important regional paper on Katanga and Northern Rhodesia, involving a review of South African structure as a whole. He believes that the extensive lava-flows of East Africa were connected with subsidences which date back to Middle

Carboniferous times (p. 95), and that the Karroo strata of Katanga and Rhodesia were formed in the lowered areas. The "graben" of the great lake region is of much younger age. H. S. Harger, in his presidential address (vol. xvi., p. xxii.), points out that the Drakensberg lavas are of Jurassic age, and probably extended at one time right across the Free State. He is concerned with the immense amount of subsequent denudation, but does not explain how the "vast peneplain" over the entire Karroo (p. xxviii.) came about, if the surface remained high above sea-level. A great inland lake might, of course, supply a base-level. He contrasts the periods of great river-action with those of subsequent desiccation, and gives striking illustrations of denudation by sand-storms in German South-West Africa. May we ask that this energetic society should consider those members who cannot promptly bind the Transactions? They have a way of falling to pieces when one cuts the pages which renders them very liable to denudation.

F. Oswald, well known for his researches in Armenia, has described "The Miocene Beds of the Victoria Nyanza and the Geology of the Country between the Lake and the Kisii Highlands" (Quart. Journ. Geol. Soc. London, vol. lxx., 1914, p. 128). His journey through a fly-infested region was undertaken to collect vertebrate remains from lacustrine strata, which underlie extensive flows of nepheline-basalt. C. W. Andrews describes the mammalia, including Dinotherium and two anthracotheres, and R. Bullen Newton shows that the associated freshwater mollusca represent existing species. The mammalia, however, assign the deposits, which were formed probably in a delta, to the Burdigalian epoch, and the history of the Victoria Nyanza is thus carried back into the middle of Cainozoic time.

R. B. Newton enters the African field in another paper (Records of the Albany Museum, Grahamstown, vol. ii., 1913, p. 315), in which he shows that the extensive Alexandria formation of the Cape Province is of Cainozoic age, and distinct from the Cretaceous strata occurring near East London. Several new molluscan species are represented in a beautiful series of photographic plates.

A. E. V. Zealley ("Zinc and Lead Deposits of Broken Hill, N. Rhodesia," South African Journ. Sci., vol. viii., 1912, p. 396), remarks that the phosphates in this area, including the beautiful deposits of hopeite, are connected with the decomposition of a bone-breccia, and that vanadinite arises in connection with the zinc and lead phosphates in a way which suggests that vanadium occurs also in the bones.

THE INSTITUTE OF METALS.

IN the study of the constitution of alloys, as well as in the practical and commercial use of both pure metals and alloys, that form of heat treatment known as annealing plays an important part, and a complete knowledge of the effects of various temperatures and conditions of annealing is of vital importance. This statement is not invalidated by the fact that many of our large metal works conduct their annealing operations in the most crude and haphazard way, a state of affairs which is, happily, becoming a thing of the past. In this connection it is interesting to note that one-third of the papers read at the recent meeting of the Institute of Metals deal, to a greater or less extent, with this important subject. J. Phelps shows that the presence of hydrogen in the atmosphere surrounding silver which is being annealed, increases the temperature required to obtain complete softness in thirty minutes, from below 150° C. to about 300° C. F. Johnson emphasises the necessity of annealing Admiralty brass castings to a temperature of about 700° C. Bengough and Hanson show that copper tested to destruction in an oxidising atmosphere has an elongation four times as great, and a maximum stress one-third as great, as that obtained when the test is carried out in a neutral atmosphere such as carbon dioxide.

Bengough and Hanson's paper also contains much interesting information as to the tensile properties of copper at high temperatures. They show that this metal fits in very well, on the whole, with Rosenhain's amorphous theory, the fracture changing from a ductile, crystalline one at low temperatures, to a non-ductile, intercrystalline, and very brittle one at high temperatures. A remarkable difference, however, is that Rosenhain and Ewen found that the intercrystalline fracture occurred within a few degrees of the melting point, whereas the present workers have found that, in the case of copper, it is evident as low as 720° C., or about 350° C. below the melting point.

From time immemorial, manufacturers of zinc-copper alloys have known that, at temperatures somewhat below a red heat, 60/40 brass becomes very brittle, recovering its normal strength as it cools. This fact was referred to by Bengough and Hudson in a paper read to the Institute of Metals in September, 1910. At the next meeting Carpenter and Edwards showed that there was an arrest point occurring at about 470° C. in the heating and cooling curves of this alloy. They pointed out that this could be explained by assuming either (1) that there was a polymorphic modification of the β constituent at this temperature, or (2) that the β splits up into $\alpha+\gamma$. On microscopic and other grounds they accepted the latter view. In the discussion which followed the reading of the paper, Mr. Hudson, amongst others, confessed himself unable to accept Prof. Carpenter's interpretation. Since then the fray has raged more or less continuously between the supporters of the two theories, and at this meeting a paper has been read by Mr. Hudson, which, in the opinion of the writer, definitely settles the question in favour of the polymorphic theory. Briefly, the β constituent has been synthetised from α and γ at temperatures below 470° C., *i.e.* at a temperature at which the "decomposition theory" supposes that it does not exist in equilibrium. This result was obtained by annealing a piece of 70/30 brass in contact with a piece of zinc at a temperature ranging between 420° C. and 430° C.; after annealing for several days, a section was cut at right angles to the junction of the two metals, and it was found that β was present.

The third part of Arnold Phillip's "Contribution to the History of Corrosion" consists in a refutation of the statement (made by Bengough and Jones in their "Report to the Corrosion Committee") that coke in condenser tubes does not promote corrosion. He brings forward evidence to prove that the reverse is the case.

Thorneycroft and Turner continue the work commenced some years ago by Prof. Turner on the volatility of metals *in vacuo*. The present paper describes the results of experiments on the zinc-copper series, and the authors show that those alloys containing more than 40 per cent. of copper can be quantitatively separated into their constituent metals by distillation *in vacuo*, while in the case of those which contain less than 40 per cent., part of the copper comes over with the zinc.

Amongst other papers read at the meeting is an interesting one by Captain Belaiew, which has been reprinted already in NATURE (p. 107), a description of the Schoop process of spraying metals by R. K. Morcom, and a paper by S. W. Smith on the surface tension of molten metals.

J. L. H.

FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE.

Crosby Lockwood and Son.—Agriculture: Extensive and Intensive, Prof. J. Wrightson, in conjunction with J. C. Newsham. *Longmans and Co.*—Fungoid Diseases of Farm and Garden Crops, Drs. T. Milburn and E. A. Bessy, illustrated. *Macmillan and Co., Ltd.*—The Principles of Irrigation Practice, Dr. J. A. Widtsoe, illustrated; Stock Judging, C. W. Gay, illustrated; Agricultural Grasses, A. S. Hitchcock, illustrated. *Methuen and Co, Ltd.*—Agricultural Analysis, H. D. Grist, illustrated. *John Murray.*—Elements of Agriculture, the late Dr. W. Fream, new edition, edited by J. R. Ainsworth-Davis, illustrated.

ANTHROPOLOGY AND ARCHÆOLOGY.

Duckworth and Co.—Where Animals Talk: Folk Tales of West Africa, Rev. R. H. Nassau. *Macmillan and Co., Ltd.*—The German Excavations at Babylon, R. Koldewey, translated by Agnes S. Johns, illustrated; An Introduction to Field Archæology as Illustrated by Hampshire, Dr. J. P. Williams-Freeman, illustrated. History of Upper Assam, Upper Burmah, and North-Eastern Frontier, Col. L. W. Shakespear, illustrated; General Index to "The Golden Bough: A Study in Magic and Religion," Sir J. G. Frazer; Outa Karel's Stories: South African Folk-Lore Tales, S. Metelerkamp, illustrated. *Williams and Norgate.*—The Antiquity of Man, Prof. A. Keith, illustrated.

BIOLOGY.

D. Appleton and Co.—Plant Breeding, J. M. Coulter, illustrated. *A. and C. Black.*—Wild Life in the Woods and Streams, C. A. Palmer, illustrated; Visual Botany, A. Nightingale, illustrated. *J. and A. Churchill.*—Plant Life in the British Isles, A. R. Horwood, vols. ii. and iii., illustrated. *J. M. Dent and Sons, Ltd.*—Reptiles and Batrachians, E. G. Boulenger, illustrated; A History of Botany in the United Kingdom, Dr. J. R. Green. *W. Heinemann.*—The Romance of the Beaver, A. R. Dugmore, illustrated. *Hodder and Stoughton.*—The Mason Bees, J. H. Fabre. *H. Holt and Co. (New York).*—Essentials of College Botany, Profs. C. E. and E. A. Bessey; Economic Zoology and Entomology, Profs. V. L. Kellogg and R. W. Doane; Biology, Prof. G. N. Calkins. *John Lane.*—Birds of the Indian Hills, D. Dewar. *Longmans and Co.*—British Birds, written and illustrated by Archibald Thorburn, with 80 plates in colour, showing more than four hundred species, in four vols.; Report on the Scientific Results of the *Michael Sars* North Atlantic Deep Sea Expedition, 1910, carried out under the auspices of the Norwegian Government and the superintendence of Sir John Murray and Dr. J. Hjort. *Macmillan and Co., Ltd.*—A Treatise on Embryology, edited by W. Heape, vol. i., Invertebrata, Prof. E. W. MacBride, illustrated; Zoological Philosophy: an Exposition with regard to the Natural History of Animals, the diversity of their organisation and the faculties which they derive from it; the physical causes which maintain life within them and give rise to their various movements; lastly, those which produce feeling and intelligence in some among them, J. B. Lamarck, translated, with an introduction, by H. S. Elliot; Transpiration and the Ascent of Sap in Plants, Prof. H. H. Dixon, illustrated; The Coco-Nut, Prof. E. B. Copeland, illustrated; Manual of Weeds, A. E. Georgia, illustrated; Plant Breeding, Profs. L. H. Bailey and A. W. Gilbert, illustrated; Household Insects, G. W. Herrick, illustrated. *A. Melrose, Ltd.*—The Wonder of Life, Prof. J. A. Thomson, illustrated. *Methuen and Co., Ltd.*—Diversions of a Naturalist, Sir E. Ray Lankester, illustrated; Science from an Easy Chair, Sir E. Ray Lankester, second series, illustrated. *John Murray.*—Trees and Shrubs Hardy in the British Isles, W. J. Bean, two vols., illustrated; Life-Histories of African Game Animals, T. Roosevelt and E. Heller, two vols., illustrated. *Grant Richards, Ltd.*—Insects and Man: a Concise Account of the More Important Relations Existing between the Insect World and the Human Race, C. H. Ealand, illustrated. *The S.P.C.K.*—Floral Rambles in Highways and Byways, Rev. Prof. G. Henslow, illustrated. *The University Tutorial Press, Ltd.*—Junior Botany, Dr. F. Cavers. *John Wiley and Sons, Inc. (New York).*—Elements of Forestry, Profs. F. F. Moon and N. C. Brown.

CHEMISTRY.

D. Appleton and Co.—Chemistry in America, E. F. Smith. *A. and C. Black.*—Chemical Analysis, Qualitative and Quantitative, G. G. Gardiner, illustrated. *Cambridge University Press.*—The Chemical Examination of Water, Sewage, Foods, and other Substances, J. E. Purvis and T. R. Hodgson (Cambridge Public Health Series). *J. and A. Churchill.*—Explosives: their Manufacture, Properties, Tests and History, A. Marshall; The Chemistry of the Cyanogen Compounds, and their Manufacture and Estimation, H. E. Williams. *Gurney and Jackson.*—Technical Gas-Analysis, Dr. G. Lunge, illustrated; Technical Methods of Chemical Analysis, edited by Dr. G. Lunge, vol. iii., two parts; English Translation from the Latest German Edition, adapted to English Conditions of Manutacture, edited by Dr. C. A. Keane, illustrated. *H. Holt and Co. (New York).*—Laboratory Directions for Elementary Chemistry, H. I. Mattill. *Crosby Lockwood and Son.*—The Practical Chemistry of Petroleum and its Substitutes, Drs. C. K. Tinkler and F. Challenger, illustrated. *Sampson Low and Co., Ltd.*—The Wonderland of Modern Chemistry, Dr. G. Martin, together with a chapter on "Thermit" and its Applications, by H. S. Redgrove, illustrated. *Methuen and Co., Ltd.*—Practical Physical Chemistry, J. B. Firth; Preparations and Exercises in Inorganic Chemistry, W. Lowson; A Senior Experimental Chemistry, Drs. A. E. Dunstan and F. B. Thole, illustrated. *John Wiley and Sons, Inc. (New York).*—Text-Book of Physiological Chemistry, Prof. O. Hammarsten and S. G. Hedin, translated by Prof. J. A. Mandel, new edition; The Elements of Physical Chemistry, Prof. J. L. R. Morgan, new edition; Micro-Chemical Methods, Prof. E. M. Chamot.

ENGINEERING.

Constable and Co., Ltd.—A Study of the Circular Arc-Bow-Girder, Prof. A. H. Gibson; Masonry Applied to Civil Engineering, F. N. Taylor, illustrated. *Crosby Lockwood and Son.*—Large Electric Power Stations, Prof. Klingenberg; The Mine Wagon and its Lubrication, C. Pamely; Electric Lighters and Starters for Autocars, H. U. Cross; The Heating Power of Boilers, Economisers, and Superheaters, Prof. R. H. Smith, illustrated; Water Supplies: Their Purification, Filtration, and Sterilisation, Drs. S. and E. Rideal; Civil Engineering Types and Devices, T. W. Barber, illustrated. *Longmans and Co.*—Specification and Design of Dynamo-Electric Machinery, Prof. M. Walker, illustrated; Ropeways: their Construction and Working, P. Stephan, translated by Dr. R. F. Muirhead, illustrated; Some Considerations Regarding Cast-Iron and Steel Pipes, J. Sharp. *Scott, Greenwood and Son.*—Steam Boilers, J. Batey. *The University Tutorial Press, Ltd.*—Electrical Engineering, W. T. Maccall. *Whittaker and Co.*—Electric Light Fitting, Batstone; Polyphase Currents, Still, new edition; Alternating Current

Work, Maycock. *John Wiley and Sons, Inc. (New York).*—Pumping by Compressed Air, E. M. Ivens; Foundations, Prof. M. A. Howe; The Modern Factory, Dr. G. M. Price; Materials of Machines, A. W. Smith, new edition; Practical Irrigation and Pumping, Prof. B. P. Fleming; Surveying Manual, Prof. H. C. Ives; Structural Steel Drafting and Elementary Design, C. D. Conklin, jun.; Structure and Properties of the more Common Materials of Construction, Prof. G. B. Upton; Design of Boilers and Pressure Vessels, Profs. G. B. Haven and G. W. Swett; Mechanism of the Steam Engine and Similar Machines, Prof. W. H. James and M. W. Dole; Steam Charts, Prof. F. O. Ellenwood; American Handbook for Electrical Engineers. Edited by Prof. H. Pender and others; Hydraulics, being Vol. v. of Text-book of Mechanics, Prof. L. A. Martin, jun.

GEOGRAPHY AND TRAVEL.

A. and C. Black.—The Cradle of Mankind: Life in Eastern Kurdistan, Dr. W. A. Wigram and E. T. A. Wigram, illustrated; Outlines of Physical Geography, H. C. Barnard, illustrated; An Intermediate Text-Book of Commercial Geography, A. L. Curr; Geographical Pictures, edited by S. M. Nicholls, series ii., Crustal Movements—Depression and Elevation of the Crust; Junior Regional Geography of the Americas, J. B. Reynolds, illustrated; A First Historical Geography, A. Nightingale, illustrated. *W. Heinemann.*—Through Siberia, the Land of the Future, Dr. F. Nansen, illustrated. *Macmillan and Co., Ltd.*—The City of Dancing Dervishes, and other Sketches and Studies from the Near East, H. C. Lukach, illustrated; Arabia Infelix, G. W. Bury, illustrated. *A. Melrose, Ltd.*—Sport and Science on the Sino-Mongolian Frontier, A. de C. Sowerby. *John Murray.*—Hunting Pygmies, Dr. W. E. Geil, illustrated. *T. Fisher Unwin.*—Antarctic Adventure, R. E. Priestley, illustrated.

GEOLOGY.

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THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SECTION M.

AGRICULTURE.

ADDRESS BY A. D. HALL, M.A., F.R.S., PRESIDENT OF THE SECTION.

THE president of a section of the British Association has two very distinct precedents before him for his address; he can either set about a general review of the whole subject to which his section is devoted, or he can give an account of one of his own investigations which he judges to be of wider interest and application than usual. The special circumstances of this meeting in Australia have suggested to me another course. I have tried to find a topic which under one or other of its aspects may be equally interesting both to my colleagues from England and to my audience who are farming here in this great Continent. My subject will be the winning of new land for agriculture, the bringing into cultivation of land that has hitherto been left to run to waste because it was regarded as unprofitable to farm. To some extent, of course, this may be regarded as the normal process by which new countries are settled; the Bush is cleared and the plough follows, or under other conditions the rough native herbage gives way to pasture under the organised grazing of sheep or cattle. I wish, however, to deal exclusively with what are commonly termed the bad lands, inasmuch as in many parts of the world, though recently settled, agriculture is being forced to attack these bad lands because the supply of natural farming land is running short. In a new country farming begins on the naturally fertile soils that only require a minimum of cultivation to yield profitable crops, and the new-comers wander further afield in order to find land which will in the light of their former experience be good. Before long the supply is exhausted, the second-class land is then taken up until the stage is reached of experimentation upon soils that require some special treatment or novel form of agriculture before they can be utilised at all. Perhaps North America affords the clearest illustration: its great agricultural development came with the opening up of the prairies of the Middle West, where the soil, rich in the accumulated fertility of past cycles of vegetation, was both easy to work and grateful for exploitation. But with the growth of population and the continued demand for land no soils of that class have been available for the last generation or so, and latterly we find the problem has been how to make use of the arid lands, either by irrigation or by dry-farming where the rainfall can still be made adequate for partial cropping, or, further, how to convert the soils that are absolutely poisoned by alkali salts into something capable of growing a crop. You yourselves will supply better than I can the Australian parallels; at any rate we in England read that the wheat-belt is now being extended into districts where the low rainfall had hitherto been thought to preclude any systematic cropping.

Now, the fact that the supply of naturally fertile land is not unlimited reacts in its turn upon the old countries. During the 'eighties and 'nineties of the last century the opening up of such vast wheat areas in America, Argentina, Australia, and the development of the overseas trade, reduced prices in Europe to such an extent that in Great Britain, where the full extent of the competition was experienced, the extension of agriculture came to an end despite the continued increase of population. The area of land under cultivation has declined but little despite the growth of the towns, but the process of taking in the waste lands stopped, and much of the land already farmed fell back from arable to cheaper pasture. But as soon as production in the newer countries failed to keep pace with the growth of population, prices began to rise again, and we are now in the Old World endeavouring to make productive the land that has hitherto been of little service except for sport and the roughest of grazing. Even the most densely populated European countries contain great areas of uncultivated land; within fifty miles of London blocks of a thousand acres of waste may be found, and Holland and Belgium, perhaps the most intensively cultivated of all Western countries, possess immense districts that are little more than desert. Of the European countries, Germany has taken the lead in endeavouring to bring into use this undeveloped capital; her population is rising rapidly, and her fiscal policy has caused her to feel severely the recent increase in the prices of foodstuffs, which she has determined to relieve so far as possible by extending the productivity of her own land. It has been estimated that Germany possesses something approaching to ten million acres of uncultivated land, and a Government department has been created to reclaim and colonise this area.

Before dealing with the processes by which the rough places of the earth are to be made straight, there is one general question that deserves consideration: Is it more feasible to increase the production of a given country by enlarging the area under cultivation, or by improving the methods of the existing cultivators? There is without doubt plenty of room for the latter process even in the most highly farmed countries: in England the average yield of wheat is about 32 bushels per acre—a good farmer expects 40; the average yield of mangolds, a crop more dependent upon cultivation, is as low as 20 tons per acre when twice as much will not be out of the way with good farming. A large proportion of the moderate land in England is kept in the state of poor grass—even as grass its production might be doubled by suitable manuring and careful management, while under the plough its production of cattle-food might easily be trebled or quadrupled. Why, then, trouble about adding to the area of indifferent land when so much of what has already been reclaimed, upon which the first capital outlay of clearing, fencing, roadmaking, etc., has been accomplished, is not doing its duty? We are at once confronted by the human factor in the problem. The existing educational agencies which will have to bring about better farming will only slowly become effective, and however imperfect they still may be in England, they are mainly so because of the lack of response upon the part of the farmers. The present occupiers of the land do obtain in many cases a very inadequate return from it, but they make some sort of a living and they hold it up against others who, though they want land, cannot be guaranteed to use it any better. Improved farming means more enterprise, more knowledge, often more capital, and the man who can bring these to the business is far rarer than the man who, given a piece of land even of the poorest quality, will knock a living out of it by sheer hard work and doggedness. While, then, there should be no slackening in our efforts to improve the quality of the management of existing land, there is a case for also using every effort to increase the cultivable area; indeed, it is probable that for some time to come the second process will add most to both the agricultural production and the agricultural population.

Let us now consider what are the factors which determine the fertility of the land that is first brought into cultivation and remains the backbone of farming in the old settled countries. Foremost comes rainfall, and the distribution is almost as important as the amount. Winter rain is more valuable than summer, and though cereal-growing is none the worse and may even obtain better results with a rainless summer, stock-raising and the production of fodder crops are the better for a rainfall that is distributed fairly evenly throughout the year. Rainfall, again, must bear some relation to temperature; some of the best farming in the Eastern Counties of England is done on an average rainfall of 20 inches; there are great areas in South Africa with the same average rainfall that are little better than desert. In temperate regions we may say that the naturally fertile land requires a rainfall of from 20 to 50 inches per annum, not too much segregated into seasons, and some at least falling in the winter.

If the rainfall is excessive or the drainage inadequate to carry it off, the formation of peat is induced, resulting in such uncultivated areas as the bogs of Ireland and the moors of Eastern England, Holland, and Germany.

Given suitable rainfall and temperature the texture of the soil becomes a factor of importance; if too coarse and sandy, so little of the rainfall is retained that we get all the effects of drought secondarily produced. In itself the open texture of a coarse, sandy soil is favourable to plant development; under irrigation, or where the situation is such as to result in permanent water a short distance below the surface, fine crops will be produced on sandy soils that would remain almost barren if they only depended upon the rainfall for their water. In Western Europe large areas of heaths and waste land owe their character to the coarse and open texture of the soil. At the opposite extreme we find clays so heavy that their cultivation is unprofitable; such soils, however, will carry grass and are rarely left unoccupied. For example, in the south-east of England there are a few commons, *i.e.*, land which has never been regarded as worth enclosing and bringing into particular ownership, situated on heavy clay land; most of such land is pasture, often of the poorest, or, if at any elevation, has been covered with forest from time immemorial.

One last factor in the soil is of the utmost importance to fertility, and that is the presence of lime—of calcium carbonate, to be more accurate—in quantities sufficient to maintain the soil in a neutral condition. Old as is the knowledge that lime is of value to the soil, we are only now beginning to realise, as investigation into the minute organisms of the soil proceeds, how fundamental is the presence of lime to fertility. A survey of the farming of England or western Europe will show that all the naturally rich soils are either definitely calcareous or contain sufficient calcium carbonate to maintain them in a neutral condition even after many centuries of cultivation. Examples are not lacking where the supply of calcium carbonate by human agency has been the factor in bringing and keeping land in cultivation. I have discussed one such case on the Rothamsted estate, and several others have come under my notice. The amelioration of non-calcareous soils by treatment with chalk or marl from some adjacent source has been a traditional usage in England and the North of France: Pliny reports it as prevailing in Gaul and Britain in his day, and the farmer of to-day often owes the value of his land to his unknown predecessors who continuously chalked or marled the land. Upon the presence of carbonate of lime depends the type of biological reaction that will go on in the soil, the beneficial bacterial processes that prepare the food for plants only take place in a medium with a neutral reaction. The Rothamsted soils have provided two leading cases. I have shown that the accumulation of fertility in grass-land left to itself and neither grazed nor mown, so that virgin conditions were being re-established, was due to the action of the organism called Azotobacter, which fixes free nitrogen from the atmosphere, and was indirectly determined by the presence of calcium carbonate in the soil, without which the Azotobacter cannot function. Examination of typical examples of black soils from all parts of the world, the prairies of North America, the steppes of Russia and the Argentine, New Zealand and Indian soils, showed in all of them the Azotobacter organism and a working proportion of carbonate of lime. Now, as we know, all virgin soils are not rich, and only in a few parts of the world are to be found those wonderful black soils that are often several feet in depth and contain 10 to 20 per cent. of organic matter and 3 to 5 parts per thousand of nitrogen. These soils are all calcareous, they occur in regions of a moderate rainfall inducing grass-steppe or bush conditions, and the annual fall of vegetation provides the organic matter which the Azotobacter requires as a source of energy in order to fix nitrogen. Non-calcareous soils under similar climatic conditions do not accumulate nitrogen and become rich; in the absence of carbonate of lime the nitrogen-fixing organisms are not active, and the soil only receives from the annual fall of vegetation the nitrogen that was originally taken from it. There is but a cyclic movement of nitrogen from the soil to the plant and back again, whereas in the calcareous soils there is also continuous addition of fresh nitrogen derived from the atmosphere, in which process the carbonaceous part of the annual crop supplies the motive power.

The other leading case to be found at Rothamsted is that of certain grass-plots which have artificially been brought into an acid condition by the continued application of sulphate of ammonia. In these soils nitrification is suspended, the nitrification organisms have even disappeared, though the herbage still obtains nitrogen because most plants are able to utilise ammoniacal nitrogen as well as nitrates. The interesting feature, however, is that the decaying grass on these acid soils passes into the form of peat, a layer of which is forming upon the surface of the soil, though nothing of the kind is found on adjacent plots where the use of lime or of alkaline manures has prevented the development of acidity. From this we may learn that the development of a surface layer of peat, independent of waterlogging (when another kind of peat forms even under alkaline conditions), is determined by the acidity of the soil, when certain of the bacterial processes of decay are replaced by changes due to micro-fungi which do not carry the breaking-down of organic matter to the destructive stage. This affords us a clue to the origin of many areas of upland peat in the British Isles, where the remains of ancient forest roots and stumps of trees are found on the true soil surface below the layer of peat, but where there is no water-logging to bring about the death of the trees and the formation of peat. We may suppose that when the land-surface became fit for vegetation at the close of the glacial epoch it covered itself with a normal vegetation, chiefly dwarf forest, because of the rainfall and temperature. The soil, however, being without carbonate of lime, would in time become acid with the products of decay of the vegetable matter falling to the ground, and as soon as this acid condition was set up peat would begin to form from the grassy surface vegetation. The process would continue until the acid conditions and the depth of the accumulating layer of peat would kill the trees, the stumps of which would remain sealed up below the peat. I am far from thinking that this explanation is complete, but at least we have facts in sight which could lead one to suppose that a non-calcareous soil originally neutral and carrying a normal vegetation can naturally become acid, alter the character of its vegetation, and clothe itself with a layer of peat. The point of economic importance is that these peaty acid soils are of very little value as long as they are acid, though they take on a quite different aspect if they are limed and made neutral.

Of all the soil factors making for fertility I should put lime the first; upon its presence depend both the processes which produce available plant food in quantities adequate for crop-production at a high level and those which naturally regenerate and maintain the resources of the soil; it is, moreover, the factor which is most easily under the control of the agriculturist.

I need say little about those cases in which infertility is due to the presence in the soil of some substance which is actually injurious to plant-growth, because such substances are nearly always due to the physical environment of the soil, to too much or too little water. In waterlogged situations we may find in the soil peaty acids, iron salts, sulphides, etc., inhibiting the growth of plants; in arid regions the soil may still be charged with an excess of soluble compounds of the alkalis and alkaline earths, resulting from the decomposition of the rocks that have been broken down to form the soil, but which through the inadequate rainfall have never been washed out. The establishment of normal conditions of growth, irrigation in one case, drainage in the other, will speedily result in the removal of the deleterious substances. Practically, only bodies that are soluble can get into a plant to injure it, hence such bodies can be removed from the soil by water, provided that the water can find its way through the soil and escape.

Let us now consider the various methods by which land suffering from one or other of the disabilities we have just discussed is nowadays being brought into cultivation. The most important, if we consider the area affected, is the extension of cropping into regions of a deficient rainfall by means of what has been termed dry-farming. So far as its immediate methods go, dry-farming consists in nothing more than the application of the principles of husbandry worked out by English farmers in the east and south-east of England, principles first expounded by Jethro Tull, though a complete explanation was not then possible, even if it is now. In the first place, the tilth must be made both deep and fine, thus whatever rain falls will be absorbed and the conditions favouring a deep and full root range will have been established. Next, the soil below the surface, though finely worked, must be compact, because only thus can the water present travel to the roots of the plant. Lastly, a loose layer must be maintained on the surface, which, though dry itself, acts as a screen and a barrier to prevent loss of water from the effective soil below by any other channel than that of the plant. Granted these methods of cultivation, the new feature about "dry-farming," which has been introduced by settlers in the arid districts of Australia and North America, is the use of a year of bare fallow in which to accumulate a supply of water for the next year's or two years' crop. This raises the fundamental question of how much water is necessary for the growth of an ordinary crop. The first investigation that Lawes and Gilbert carried out at Rothamsted dealt with this very point; they grew the usual field crops in pots, protected the surface of the soil from evaporation so that all the loss of water proceeded through the plant, weighed the water that was supplied from time to time, and finally weighed the produce, expressing their results as a ratio between the dry matter produced and the water transpired by the plant. These experiments have been repeated under different climatic conditions by Hellriegel in Heidelberg, by Wollny in Vienna, by King and others in America. Now the two processes in the plant, carbon assimilation and transpiration, are not causally connected, though, as both are carried out in the leaf and have some factors in common, they are found to show some constancy in their relative magnitudes. Lawes and Gilbert obtained a ratio of about 300 lb. of water transpired for each pound of dry matter harvested, but the other investigators under more arid conditions found much higher figures, up to 500, and even 700 to 1. Now, a crop yielding 20 bushels of wheat per acre will contain about a ton of dry matter per acre, so that, taking the high ratio of 500 to 1, no more than 500 tons of water per acre or 5 in. of rain will have been consumed in the production of this crop.

It is, of course, impossible to ensure that all the rain falling within a year shall be saved for the crop; much must evaporate before it reaches the subsoil where it can be stored, and only when the crop is in full possession of the land can we expect that all the water leaving the soil shall go through the crop. What proportion the waste bears to that which is utilised will depend not only on the degree of cultivation, but upon the season at which the fall occurs; summer showers, for example, that do not penetrate more than a few inches below the surface will be dissipated without any useful effect. When the climatic conditions result in precipitation during the winter, the water will be in the main available for crop-production; and it has been found by experience that cereals can be profitably grown with as small a rainfall as 12 in. The necessary cultural operations consist in producing such a rough surface as will ensure the water getting into the subsoil; hence autumn ploughing is desirable. Where the precipitation is largely in the form of snow, a broken surface also helps both to absorb the thawing snow and to prevent it being swept into the gullies and hollow places by the wind. On some of the Russian steppes it has become customary to leave a long stubble in order to entangle as much snow as possible, but probably a rough ploughing before the snowfall would be even more effective. When the rainfall drops to the region of 12 to 16 in., and occurs during the summer months, then dry-farming methods and the summer fallow become of the first importance. The deep cultivation ensures that the water gets quickly down to the subsoil away from danger of evaporation, and the immediate renewal of a loose surface tilth is essential in order to conserve what has thus been gained.

In connection with this dry-farming there are several matters that still require investigation before we can decide what is the minimum rainfall on which cultivation can be profitable. In the first place, we are only imperfectly informed as to the relation between rainfall and evaporation. At Rothamsted there are three drain-gauges side by side, the soil layers being 20, 40, and 60 in. deep respectively. The surface is kept rough and free from growth, though scarcely in the condition of looseness that could be described as a soil mulch. Yet the evaporation, even under a moist English atmosphere, amounts to one-half of the annual rainfall, and the significant thing is that the evaporation is approximately the same from all the gauges and is independent of the depth of subsoil within which water is stored. Evaporation then would seem to be determined by surface alone, but we are without systematic experiments to show how variations in the surface induced by cultivation will alter the rate of evaporation. A knowledge of the evaporation factor would then inform us of what proportion of the rainfall reaches the subsoil; we then want to know to what extent it can be recovered, and how far it may sink beyond the reach of the crop. It is commonly supposed that the subsoil below the actual range of the roots of the crop may still return water by capillarity to the higher levels that are being depleted, the deeper subsoil thus acting as a kind of regulating reservoir absorbing rain in times of excess and returning it when the need arises. But some work of Leather's in India and Alway's on the great plains of North America throw doubt on this view, and would suggest that only the layer traversed by roots, say, down to a depth of 6 ft., can supply water to the crop; the water movements from the deeper layers due to capillarity being too slow to be of much effect in the maintenance of the plant. The evidence on either side is far from being conclusive, and more experiment is very desirable.

It would also be valuable to know how far evaporation from the bare soil can be checked by suitable screens or hedges that will break the sweep of the wind across the land. In England hedges have always been looked at from the point of view of shelter from stock; we find them most developed in the grazing districts of the west, while bare, open fields prevail in the east and south. Yet the enormous value of a wind-screen to vegetation can be readily observed, and the market-gardeners both in England and the still dryer districts of the south of France make great use of them. Lastly, we must have more knowledge about the relation between transpiration-water and growth; we do not know if the high ratios we have spoken of hold for all plants. Xerophytic plants are supposed to be possessed of protective devices to reduce loss of water. Are they merely effective in preserving the plant from destruction during the fierce insolation and drying it receives? and do they enable a plant to make more growth on a given amount of water? Wheat, for example, puts on its glaucous, waxy bloom under dry conditions: Is this really accompanied by a lower rate of transpiration per unit surface of leaf? and is it more than defensive, connoting a better utilisation of the water the plant evaporates?

The cultivation of these soils with a minimum rainfall necessitates varieties of plants making a large ratio of dry matter to water transpired, and also with a high ratio between the useful and non-useful parts of the plant. Mr. Beaven has shown that the difference in the yields of various barleys under similar conditions in England are due to differences in their migration factors: the same amount of dry matter is produced by all, but some will convert 50 per cent. and others only 45 per cent. into grain. This migration ratio, as may be seen by the relation between corn and straw on the plots at Rothamsted, is greatly affected by season; nevertheless, Mr. Beaven's work indicates that under parallel conditions it is a congenital characteristic of the variety, and therefore one that can be raised by the efforts of the plant-breeder. The needs of dry-land farming call for special attention on the part of the breeder to these two ratios of transpiration and migration.

Closely linked up with the problems of dry-land farming are those which arise in arid climates from the use of irrigation water on land which is either impregnated with alkaline salts to begin with or develops such a condition after irrigation has been practised for some time. The history of irrigation farming is full of disappointments due to the rise of salts from the subsoil and the subsequent sterility of the land, but the conditions are fully understood, and there is no longer any excuse for the disasters which have overtaken the pioneers of irrigation in almost every country. Sterility may arise from two causes—overmuch water, which brings the water-table so close to the surface that the plants' roots may be asphyxiated, or the accumulation by evaporation of the soluble salts in the surface layer until plants refuse to grow. The annual cutting off of the cotton crop in Egypt as the water-table rises with the advance of the Nile flood affords a good example of asphyxiation, but in the neighbourhood of irrigation canals we also find many examples of sterility due both to the high water-table and an accompanying rise of salts. The governing principle is that drainage must accompany irrigation. Even if free from salts at the outset, the land must accumulate them by the mere evaporation of natural waters, and they will rise to the surface where they exert their worst effect upon vegetation, unless from time to time there is actual washing through the soil and removal of the water charged with salt. Without drainage the greater the quantity of water used the greater the eventual damage to the soil, for thereby the subsoil water-table carrying the salts is lifted nearer to the surface. With a properly designed irrigation system the danger of salting ought not to occur; there are, however, many tracts of land where the supply of water is too limited to justify an expensive scheme of irrigation channels with corresponding drainage ditches at a lower level.

Take the case of a farmer with some water from an artesian well at his disposal, with perhaps little rainfall, with land subject to alkali, and no considerable natural fall for drainage. If he merely grades the land and waters it, sterility rapidly sets in; the only possibility appears to be to take a comparatively limited area and to cut out drainage ditches or tile drains 4 or 5 ft. below the surface, even if they have to be led into a merely local hollow that can be abandoned to salt. The bed thus established must then be watered at any cost until there is a flow in the drains, after which the surface is immediately cultivated and the crop sown. There should be no further application of water until the crop covers the land, the use of water must be kept to a minimum, and by the ordinary methods of dry cultivation evaporation must be allowed only through the crop, not merely to save water, but to prevent any rise of salt. With a loose surface and wind-breaks to minimise evaporation it has thus proved possible to grow valuable crops even on dangerously alkaline land. Superphosphate and sulphate of ammonia have proved to be useful fertilisers under these conditions; both tend to prevent the reaction of the soil becoming alkaline, and the calcium salts of the superphosphate minimise the injurious effects of the sodium salts that naturally accumulate in the land. On the other hand, nitrate of soda is a dangerous fertiliser. Attempts have been made to reduce the salts in the land by the growth of certain crops which take up a large proportion of mineral matter, but I have not been able to ascertain that much good can be thus effected. Sugar-beet and mangolds do appreciably reduce the salt content, but are scarcely valuable enough to pay for such special cultivation and the limited irrigation water; the best thing appears to be to grow saltbush on the non-irrigated margin of such areas, if only to prevent the efflorescent salts from blowing on to the cultivated portion.

Let us now turn to the problem of land reclamation as it occurs in north-western Europe. There are two main types of land that have hitherto been left waste, the peaty and the sandy areas. Of the peaty areas we can distinguish again between the low-lying moors bordering the lower courses of the great rivers; for example, in England near the mouth of the Trent, and the upland peat-bogs of which Ireland furnishes so many examples. They have these features in common—an excess of water, a deficiency of mineral salts, and, particularly in the upland bogs, a strongly acid reaction; but they possess great potential wealth in their richness in nitrogenous organic matter. It is in Germany and Holland that the methods of bringing into cultivation these moors have been most completely worked out; in Germany, for example, it is estimated that there are about five million acres of moorland of which about 10 per cent. are now under cultivation. The reclamation process must begin by drainage, which may be carried out by open ditches, but is most satisfactorily effected by pipes, despite the greater cost. The water-table must be kept some 3 ft. below the surface. In districts which afford a market for peat, as, for example, on the Teufelsmoor near Bremen, the reclamation often begins by cutting out the peat, the lower layer of firm peat being won, dried, and sold for fuel. The upper spongy peat can be used for litter, but some part at least must be thrown back. Where the burning peat is thus extracted the excavation is in places pushed further until the underlying sand is reached, and enough of this is dug to spread over the reclaimed area to a depth of 4 or 5 in. and mixed by cultivation with the spongy peat. Even when the peat is not removed, pits are often made in order to sand the land, so great an improvement does it effect in the character of the crops. However, sanding is not possible everywhere, and there are great areas under cultivation where the reclamation begins with drainage, followed by the cultivation of the immediate surface without either sanding or the removal of the burning peat, which indeed are impossible over large areas, but are carried out by the owners of small farms little by little. Special tools are required: certain forms of disc-ploughs and harrows give the best results; heavy tools for large scale cultivation by steam or electricity are furnished with broad roller-like wheels; even the horses must wear broad wooden shoes.

The next stage is the manuring, and it has only been the development of the artificial fertiliser industry during the last half-century that has rendered the cultivation of this type of land possible. On the alluvial moors where the ground water has always been alkaline, the peat is rich in calcium and no treatment with lime and marl is necessary (the English fens afford an example of this type of soil), but on the true peat-bogs (Hochmoor of Germany) the manuring must begin with a good dressing of burnt lime, or, better, of marl or ground chalk. For meadows and pastures two tons per acre of lime, or twice as much of carbonate of lime, should be applied; the amounts may be halved for arable land. This must be followed by about 5 to 8 cwt. per acre of basic slag and an equal amount of kainit, which applications should be renewed in the second year, but then diminished in accord with the cropping. However, some phosphoric acid and potash salts must be continuously supplied, with occasional dressings of lime or chalk on the acid peaty areas. These latter also require in their earlier years nitrogenous manures, for the peat is slow to yield up the nitrogen it contains. The fertilisers should be nitrate of soda or lime, never sulphate of ammonia. The whole success of the reclamation depends on the use of these manures, as the peat in a state of nature is almost devoid of both phosphoric acid and potash; on the acid peats, again, normal growth is only possible after a neutral reaction has been attained by the use of lime or marl. With this manuring it is found to be easy to establish a good meadow herbage in a very short space of time; it is not even necessary to get rid of the surface vegetation of Erica and other heath and bog plants. The manure is put on and the surface is worked continuously with disc-harrows and rollers, but never deeply; a seed-mixture containing chiefly red, white, and Alsike clovers, *Lotus uliginosus*, rye-grass, Timothy, and cocksfoot, is sown in the spring and soon succeeds the native vegetation.

It is impossible to say what is the cost of the reclamation of moorland in this fashion; the big expense is the drainage and the construction of roads, both of which are entirely determined by local conditions. But of the value of the process when accomplished there can be no doubt. I have seen a case quoted from the *Ostfriesische Zeitung*, where a piece of moor bought for 75*l*. was reclaimed and sold for 900*l*.; and, best test of all, one may see in places like the Teufelsmoor, near Bremen, families living in comfort on thirty to forty acres of what was once merely wild moor with no productive value.

Of even greater interest in England is the reclamation of heath-land, which has of late years been proceeding apace in Germany. In this category we may include all land which owes its infertility to the coarse grade and low water-retaining power of the particles of which the soil is composed, the soil being at the same time as a rule devoid of carbonate of lime, and covered in consequence with heather and similar calcifuge plants. In England there exist extensive tracts of uncultivated land of this character in close proximity to the considerable populations, but the process of reclaiming such land for agriculture seems to have come to an abrupt conclusion somewhere about 1850, when the developing industries of the country began to offer so much greater returns for capital than agriculture. That land of the kind can be cultivated with success is evident from the mere fact that everywhere prosperous farms may be seen bordering the wastes, possessing soils that are essentially identical with those of the wastes. These were brought under cultivation when labour was cheaper, often without calculation of the cost because the work was done piecemeal at times when the men would otherwise have been idle. Were any strict account to be framed, the reclamation probably did not pay its way for many years, and it has only become possible again because of modern advances in science and machinery. As examples of the type of land, I may instance the Bagshot Sands on which, in north Surrey, in Berkshire and Hampshire, and again in its southern development in the New Forest, lie so many thousands of acres of uncultivated heath. No systematic reclamation has taken place, but everywhere farms have been carved out on this formation, often by the industry of squatters, and within reach of London the vast supplies of town manure which used to be available have converted some of it into fertile land. The crystallisation of common rights into charters for public playgrounds, its growing appreciation for residential purposes, will now always stand in the way of the utilisation of most of the Bagshot Sands for agriculture, but further afield there are many areas of similar character.

The Lower Greensand is perhaps equally discounted by its residential value, but on the Tertiaries of Dorset, the Crag and Glacial Sands of Suffolk and Norfolk—the brak, the Bunter Beds of the midlands, lie many expanses of waste that are convertible into farming land, just as Lincoln Heath and much of the beautifully farmed land of Cheshire have been gained for agriculture within the past century. Equally possible is an attack upon the sandy areas, warrens or links, behind the sand-dunes on many parts of the English and especially the Welsh coasts; not all of them are wanted for golf, and many can be fitted for market-gardening. Of old the only way of dealing with such land was merely to clear it, burn the rubbish, and start upon the ordinary routine of cultivation, but for a long time on such a system the crops will scarcely pay their way from year to year, and the permanent deficiencies of the soil in lime and mineral salts remain unrepaired. In Cheshire the enormous value of marl and bones in such a connection was early recognised; it has been the later discovery of the potash salts that renders reclamation a commercial proposition to-day. The method that is now followed is to begin by clearing the land of shrubs, burning off the roughest of the vegetation, and turning over a shallow layer in the summer, leaving the heathery sod to the killing and disintegrating action of sun and frost until the following spring. The manure is then put on—lime or ground chalk or marl as before, basic slag and kainit, and the sod is worked down to a rough seed-bed on which lupins are sown, to be ploughed in when they reach their flowering stage. The growth of the lupins makes the land, they supply humus to bind the sand together and retain moisture, they draw nitrogen from the atmosphere, and with the phosphoric acid and potash form a complete manure for succeeding crops. Sometimes a second crop of lupins is ploughed in, but usually the land is put immediately to an ordinary rotation of rye, oats, potatoes, and clover. When the heath-land is divided among small tenants in an unreclaimed state cropping often begins without the lupins, the necessary nitrogen being imported by nitrate of soda, but for years the land shows inferior results. Only the tenant can rarely afford to lose the year the lupin crop involves, and so great is the demand for land in Germany that the State finds its preferable to let the tenant reclaim than to reclaim for him, and charge him as rent the cost of the more thorough process.

And now as to the finance of the operation: the reclaiming down to the ploughing in of the lupin crop costs from 5*l.* to 6*l.* an acre, the bare heath costs from 5*l.* to 7*l.* an acre, the reclaimed land after a few years' cultivation would sell at 20*l.* to 30*l.* an acre. Meantime the State has probably made a free grant for drainage, looking to get some interest back in increased taxation; the local authority has also made roads for which the increased rating due to a new agricultural community must be the only return. It is a long-sighted policy which will only find its full justification after many years when the loans have all been paid off and the State has gained a well-established addition to its agricultural land and its productive population. In comparing English with German conditions there are certain differences to be taken into account—in the first place the work of reclamation will be dearer in England because of the higher price of labour, then the land will not be so valuable when won because the higher scale of prices for agricultural products enhances the price of land in Germany. Next, I doubt, in view of the great industrial demand for men in England, if we have the men available who will bring to the land the skill and power of drudgery that I saw being put into these German holdings of thirty to forty acres in their earlier years of low productivity. Moreover, in Germany these heaths are generally bordered by forests, in which the smallholder gets occupation for part of the year while his wife and children keep the farm going. For this, if for no other reason, afforestation and land reclamation and settlement should go on together. But, despite these drawbacks, I am still of opinion that the reclamation of such heath-lands is a sound commercial venture in England, either for a landowner who is thinking of a future rather than of a present return on his capital, or for the State or other public body, wherever the waste land can be acquired for less than 5*l.* an acre. The capitalised value of its present rental rarely approaches that figure, but the barrenest heath is apt to develop the potentialities of a gold-mine when purchase by the State comes in question. The map of England is so written over in detail with boundaries and rights and prescriptions that the path of the would-be reclaimer, who must work on a large scale if he is to work cheaply, can only be slow and devious.

There are other possibilities of winning agricultural land even in England, from the slob land and estuaries, from the clays nowadays too heavy for cultivation; but the problems they present are rather those of engineering than of agricultural science. What I should like in conclusion once more to emphasise is, that the reclamation of heath and peat-land of which I have been speaking—reclamation that in the past could only be imperfectly effected at a great and possibly unremunerative expense of human labour—has now become feasible through the applications of science—the knowledge of the functions of fertilisers, the industrial developments which have given us basic slag and potash salts, the knowledge of the fertility that can be gained by the growth of leguminous plants. From beginning to end the process of reclamation of moor and heath, as we see it in progress in north-western Europe, is stamped as the product of science and investigation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. J. T. Saunders, of Christ's College, has been appointed demonstrator in animal morphology, and Mr. J. Gray, of King's College, has been appointed demonstrator in comparative anatomy. Mr. Saunders has received a commission in the Army, but his post will be kept open for him until the end of the war. Mr. J. R. Menon, intercollegiate student, has been nominated to use the University table at the Zoological Station at Naples.

The following forms part of the address of the Vice-Chancellor of the University, Dr. M. R. James, provost of King's College, on his re-election at the beginning of this month:—

"The remembrance of what has been brilliant or sorrowful in the three terms has paled, for the time at least, before the events of the Long Vacation. The University meets in such circumstances as it has never known. We shall be few in number, and perpetually under the strain of a great anxiety. We may be exposed to actual peril: in any case, we must look forward to straitened resources and, what is more, personal sorrows. Yet there is no doubt that we are bound to carry on our work; for by it we can render definite service to the nation. Our part, while we encourage all of our students who are capable of doing so to serve their country, and while we surrender to that service many valued teachers, is to prepare more men—especially in our medical schools—for rendering active help, and to keep alive that fire of 'education, religion, learning, and research' which will in God's good time outburn the flame of war. Let us devote ourselves to making useful men of the new generation. Let us confine our own controversies within the narrowest limits, and be ready if necessary to postpone them altogether. Let our advanced work—however irrelevant it may seem to the needs of the moment—be unremittingly and faithfully pursued.

"I have spoken of the trials which we are bound to anticipate as a consequence of the war. Let me add that we shall be the better able to bear them, not only because we know that our cause is just, but because we know that the University has contributed a worthy share of its sons to champion that cause. Nearly 2000 applications for commissions from our younger graduates and our undergraduates have passed through the hands of the indefatigable committee of the Board of Military Studies; and this number does not include the very large contingent who have applied through other bodies, those who already held commissions at the outbreak of war, those who have enlisted in the ranks of various branches of the service, or those who are giving their help in tending the sick and wounded without enlisting. It is not at this moment possible to compile accurate lists of all who have responded to the great call. I hope, however, that each college will set itself to secure information as to its own members, with a view to the ultimate publication of the roll of honour of the University.

"It is our plain duty to secure that those who have interrupted their University career for the sake of their country shall suffer the least possible amount of disadvantage thereby. Some measures have already been taken with this object, and others will be necessary.

"I shall have, further, to ask for your co-operation in an effort which is being made to enable some of those Belgian students who in the course of their gallant resistance have been deprived of their whole academic equipment, to continue, in our midst, and with the help of our libraries and teaching apparatus, the life of their universities. This is an object which, I am confident, the Senate will feel honoured in supporting."

The next combined examination for fifty-three entrance scholarships and a large number of exhibitions, at Pembroke, Gonville and Caius, Jesus, Christ's, St. John's, and Emmanuel Colleges, will be held on Tuesday, December 1, and following days. Mathematics, classics, natural sciences, and history will be the subjects of examination at all the above-mentioned colleges. A candidate for a scholarship or exhibition at any of the six colleges must not be more than nineteen years of age on October 1, 1914. Forms of application for admission to the examination at the respective colleges may be obtained from the masters of the several colleges.

MR. H. PATTERSON, University of Leeds, has been appointed part-time lecturer in physical chemistry at Battersea Polytechnic.

IT is stated in *Science* that the medical school of Western Reserve University receives by the will of Mr. Liberty E. Holden a bequest said to be nearly 200,000*l*. The fund is to be known as the Albert Fairchild Holden Foundation, in memory of Mr. Holden's son.

THE Earl of Rosebery has made a donation of 1200*l*. to the London School of Economics and Political Science for the endowment of a prize to be awarded annually in the department of railway transport at that school of the University of London.

THE Rural Education Conference, which was constituted by the Board of Agriculture and Fisheries and the Board of Education in June, 1910, was appointed for a term of three years. This period having expired, the conference has been reconstituted by the Board of Agriculture and Fisheries under the name of the Agricultural Education Conference. The duty of the conference will be to discuss, and to advise, the Board upon, all questions connected with agricultural education which fall within the province of the Board of Agriculture and Fisheries, and specific questions will, from time to time, be referred by the Board to the conference for consideration. In addition, any member may suggest for discussion questions other than those formally referred to the conference. The Lord Barnard has been appointed chairman of the conference, and Mr. H. L. French (Board of Agriculture and Fisheries, Whitehall Place, S.W.) will act as its secretary.

DETAILED information as to the work of the numerous departments among which the varied activities of the University of Leeds are shared is contained in the calendar for 1914–15. In common with other modern universities, Leeds University includes a faculty of technology, and among its staff are to be found professors of engineering, mining, textile industries, tinctorial chemistry, and dyeing, leather industries, coal gas and fuel industries, and agriculture. Students may graduate in applied science as well as in pure science. The University, which is situated in the heart of a mining district possessing some of the deepest and best equipped of modern English collieries, enjoys the cordial support of the owners and managers of mines, who give the department every facility for instructing its students. The courses in gas engineering and the technology of fuel meet the requirements of students who are preparing for responsible positions either as gas engineers or in fuel and metallurgical industries. In agriculture the instruction has been arranged to meet the requirements of young men who intend to become farmers, land agents, valuers, or teachers of agricultural science. Other examples could be given of the efforts of the University authorities to provide instruction and guidance for all parts of the community in its area and the support which is being given to the University by all sections of society augurs well for its future usefulness.

FROM Prof. H. S. Carslaw we have received a report, presented to the International Commission, dealing with the teaching of mathematics in Australia, and now published by Angus and Robertson, Sydney, 1914. Up to the present the education in the schools has been mainly influenced by examinations of the "local" type, controlled by the Australian universities. Prof. Carslaw condemns this system, which, of course, tends to lower the educational ideal of the schools to mere examination cramming. A comparison of the syllabuses of these examinations with those now being introduced into the State high schools, and the system of leaving certificates, fully supports what Prof. Carslaw states. The older examinations contain much work that is difficult, useless, and unstimulating, while the new syllabuses are much more practical, interesting, and educationally valuable. Coming next to the universities, we find that the system of combining mathematics and physics in one department still prevails in the newer institutions, and the numbers of students taking mathematics is on the whole distinctly small, having regard of the fact that the subject is compulsory for engineering students. The course in insurance mathematics is a valuable feature of the Melbourne University, and one which we should like to see copied elsewhere and made attractive to candidates for general degrees in arts and science.

THE calendar for the present session of the Armstrong College, Newcastle-upon-Tyne, has been received. The college ranks, together with the "Durham colleges," and the College of Medicine, as one of the three constituent units of the University of Durham. The faculties of science and commerce in the University are seated entirely at Armstrong College, in which alone are held the classes and examinations requisite for bachelor degrees in these faculties. In addition to pure science, the college gives instruction in the various branches of engineering, mining, metallurgy, naval architecture, and agricultural science. The agricultural department directs the Northumberland County Agricultural Experimental Station and the Durham County Station for Dairy Research. For the purpose of forestry instruction the college possesses 900 acres of wood, and its zoological equipment includes a laboratory of marine biology. College diplomas in engineering, naval architecture, mining, mine surveying, agriculture, and commerce, are open to students who are unable to take a complete degree course. A list of the various fellowships for research, scholarships, and exhibitions, of which there is a large number, is given in the calendar. We notice that a fellowship of the value of 125*l.*, and two research studentships of the value of 62*l.* 10*s.* each, are offered for competition in June of each year. The holders must engage in advanced study or research to the satisfaction of the council and be graduates of the University of Durham.

A COPY of the calendar for 1914–15 of the Manchester Municipal School of Technology has been received. It is arranged in two parts, one dealing with university courses and the other with part-time courses. The school offers systematic training in the principles of science and art as applied to mechanical, electrical, municipal, and sanitary engineering; architecture and the building trades; the chemical industries; the textile industries; and photography and the printing crafts. Its work includes advanced study and research; university courses in the faculty of technology in the Victoria University of Manchester, of which the school is an important constituent; part-time day courses for engineers' and other apprentices whose employers allow them to devote one whole day a week to study; part-time evening courses, involving attendance on three evenings a week for five years; and other part-time classes for advanced study and research, or in preparation for the external degrees of the University of London, or for other purposes. Students who, having passed the matriculation examination or its equivalent, satisfactorily complete a three years' university course in accordance with the regulations, become entitled to the degree of Bachelor of Technical Science. A fourth year's course of advanced study and research prepares such graduates for the higher degree of Master of Technical Science. These degrees give the holders exemption from further examination when desirous of entering certain professions and learned societies, which are enumerated in the calendar. Very full particulars of the equipment, the various courses, and the general arrangements of the school are given in a manner which makes very simple reference by the intending student.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 14.—M. P. Appell in the chair.—A. **Lacroix**: The recent eruption of Ambrym (December, 1913) and the constitution of the lava from this volcano. The lava is of the angitic labradorite type, too poor in olivine to be considered a true basalt. A complete chemical analysis is given.—Kr. **Birkeland** and M. **Skolem**: Calculations of the lines of equal intensity in the zodiacal light.—B. **Jekhowsky**: The eclipse of the sun of August 20–21, 1914. Particulars of observations taken at the Observatory of Montsouris.—Ch. **Vaillant**: The replacement of photographic plates by gelatino-bromide paper in radiography. By the use of a reinforcing screen with exposures of from 4 to 30 seconds good negatives were obtained. The cost is about one-thirtieth of the ordinary plates.—Julien **Loisel**: The monographic representation of the mean direction of the wind.

September 21.—The President announced the death of M. Pérez, correspondant for the section of anatomy.—Maurice **Hamy**: Remarks relating to the construction of an equatorial *coudé*.—Marin **Molliard**: Chemical modifications of plant organs undergoing a true fermentation.

CALCUTTA.

Asiatic Society of Bengal, September 2.—W. **Ivanow**: The language of the gypsies of Qāināt (in eastern Persia). The gypsies of eastern Persia are a wandering tribe who live exclusively in tents and present signs of their Aryan origin, with Shemitic, Turkish, and even Dravidian admixtures. They seem to be allied to the Jats, the well-known Kshattriya tribe of India, to the Da-Yueti tribe to which Kaniska belongs, and to other kindred tribes. They dress like Persian peasants, and their religion is Islam of the Shia Sect. Their language has lost its original purity and is now about the same as Persian spoken in Qāināt. There are still some genuine gypsy words which are used to conceal their secrets, but words indicative of abstract ideas are wanting altogether. The paper also deals with many important features of the genuine gypsy language from the points of view of phonetics, morphology, vocabulary, etc.

BOOKS RECEIVED.

The Canterbury College, Christchurch, New Zealand. 41st Annual Report. June. Pp. 47. (Christchurch, N.Z.: Canterbury College.)

Koninklijk nederlandsch Meteorologisch Instituut. No. 106. Ergebnisse Aerologischer Beobachtungen i. 1909–12. Pp vi+146. (Utrecht: Keminck and Zoon.)

Regenwaarnemingen in Nederlandsch-Indie. Deel ii. Uitkomsten. Pp. 170. (Batavia.)

Life: Its Origin and Energy Mechanism. By Jadroo. Pp. 32. (London: H. Kimpton.) 1*s.* net.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1913–14. Pp. 49. (Barbados Imperial Commissioner of Agriculture.) 6*d.*

University of Durham. Armstrong College, Newcastle-upon-Tyne. Calendar, Session 1914–15. Pp. 534. (London and Newcastle: A. Reid and Co., Ltd.) 1*s.*

Specimens of Languages from Southern Nigeria. By N. W. Thomas. Pp. 143. (London: Harrison and Sons.) 4*s.* net.

The World of Life. By Dr. A. R. Wallace. New and cheaper edition. Pp. xvi+408. (London: Chapman and Hall, Ltd.) 6*s.* net.

Examples in Arithmetic, Extracted from the Public School Arithmetic. By W. M. Baker and A. A. Bourne. Pp. xii+217+lii. (London: G. Bell and Sons, Ltd.) 2*s.*

Modern Instruments and Methods of Calculation. Edited by E. M. Horsburgh. Pp. vii+343. (London: G. Bell and Sons, Ltd.; Edinburgh: Royal Society of Edinburgh.) 6*s.* net.

Transactions of the Royal Society of Edinburgh. Vol. xlix., part iii. Session 1912–13. Pp. 531–829. Vol. xlix., part iv. Session 1913–14. Pp. 830. Vol. l., part i. Session 1913–14. Pp. 251. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 30*s.*, 21*s.* 9*d.*, 25*s.* 9*d.* respectively.

The National Physical Laboratory. Report for the Year 1913–14. Pp. 144. (Teddington: W. F. Parrott.)

The National Physical Laboratory. Collected Researches. Vol. xi., 1914. Pp. iv+320. (London: Harrison and Sons.) 20*s.*

Department of the Interior. Weather Bureau. Annual Report of the Weather Bureau for the Year 1911. Part iii., Meteorological Observations Made at the Secondary Stations during the Calendar Year 1911. Pp. 266. (Manila: Bureau of Printing.)

Board of Agriculture and Fisheries. Annual Report of the Horticultural Branch. Proceedings under the Destructive Insects and Pests Acts, 1877 and 1907, and the Board of Agriculture Act, 1889 (Section 2, Sub-Section 3) for the Year 1913–14. Pp. vii+79. (London: H.M.S.O.; Wyman and Sons, Ltd.) 4½*d.*

The Propagation of Disturbances in Dispersive Media. By Dr. T. H. Havelock. Pp. viii+87. (London: Cambridge University Press.) 3*s.* 6*d.* net.

Lead Poisoning, from the Industrial, Medical, and Social Points of View. By Sir T. Oliver. Pp. x+294. (London: H. K. Lewis.) 5*s.* net.

The Principle of Relativity. By E. Cunningham. Pp. xiv+221. (London: Cambridge University Press.) 9*s.* net.

Experimental Studies in Electricity and Magnetism. By F. E. Nipher. Pp. 73. (Philadelphia: P. Blakiston's Son and Co.) 1.25 dollars net.

The North of Scotland College of Agriculture. Calendar, Session 1914–15. Pp. 182. (Aberdeen: Milne and Hutchison.)

The University of Leeds. Calendar, 1914–15. Pp. 698. (Leeds: Jowett and Sowry.)

Stellar Movements and the Structure of the Universe. By Prof. A. S. Eddington. Pp. xii+266. (London: Macmillan and Co., Ltd.) 6*s.* net.

The Idealistic Reaction against Science. By Prof. Aliotta. Translated by A. McCaskill. Pp. xxii+483. (London: Macmillan and Co., Ltd.) 12*s.* net.

Modern Pig-Sticking. By Major A. E. Wardrop and others. Pp. xii+304. (London: Macmillan and Co., Ltd.) 10*s.* net.

Macmillan's Geographical Exercise Books. I., The British Isles. With Questions by B. C. Wallis. (London: Macmillan and Co., Ltd.) 6*d.*

DIARY OF SOCIETIES.

MONDAY, OCTOBER 12.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates), at 8.—The Reclamation of Waste Products in Industrial Undertakings: G. H. Ayres.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—Cotton Spinning: W. Scott Taggart.

FRIDAY, OCTOBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Report of the Refrigeration Research Committee: Sir J. Alfred Ewing.

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THURSDAY, OCTOBER 15, 1914.

THE IBO-SPEAKING PEOPLE OF SOUTHERN NIGERIA.

Anthropological Report on Ibo-Speaking Peoples of Nigeria. By N. W. Thomas. Part iv., *Law and Custom of the Ibo of the Asaba District, S. Nigeria.* Pp. vi+208. Price 4*s.* net. Part v., *Addenda to Ibo-English Dictionary.* Pp. x+184. Price 4*s.* net. Part vi., *Proverbs, Stories, Tones in Ibo.* Pp. viii+114. Price 4*s.* net. (London: Harrison and Sons, 1914.)

LATE in the eighteenth century the European nations then most engaged in the slave trade—Britain, Holland, France, and Portugal—became aware that there was a vigorous, muscular race of negroes called the Ibo—a name rendered in English down to the middle of the nineteenth century Eeboe. They fed the slave markets of Benin, and thence made their way to Brazil and the slave markets of Bonny and Calabar. When Richard Lander and his brother John completed the solution of the Niger mystery and descended the Niger from the Busa rapids to the head of its delta, they were captured by a raiding party of Ibos in canoes, and taken to the headquarters of an Ibo king. Here they were ransomed by the Ijō people of Brass (one of the Niger mouths) and thence actually conveyed to the sea-coast, whence they managed to make their way home.

The sufferings of the Lander brothers directed special attention to the Ibo people, especially as Richard Lander's successful demonstration of the Niger outlets immediately led to the dispatch of trading and exploring expeditions to the River Niger, more or less under British Government supervision. For some fifty years afterwards the Ibos alternately encouraged and repelled the attempts of the British to open up the Lower Niger to commerce. They were really not brought under anything like control until the Royal Niger Company established its headquarters at Asaba in the midst of their country, thirty years ago, and it is in the Asaba district to the west of the Lower Niger that Mr. Northcote Thomas has made his chief studies of the Ibo people, especially those set forth in the three volumes under review.

The region of the Lower Niger below the confluence of the Niger and the Benue, and thence to Lagos on one hand, and Old Calabar on the other, is inhabited by principal stocks (1) the Igara-Yoruba-Jekri; (2) the Sobo-Bini (related to No. 1); (3) the Ibo-Efik; (4) the Ijō; and (5) the Akwa. There are also, perhaps, in the region between the Cross River and Opobo, and again between the main stream of the Niger or Nun and the Forcados River, traces of other negro stocks (such as the Aro) as yet isolated in affinities. The affinities of the Ibo with the Efik people of Old Calabar are not at first sight outstanding, but on examination of the two languages it is evident that there is a deep-seated and obvious relationship, and the traditions of the Calabar people would seem to show that some five hundred years ago they were the result of an Ibo invasion of a region populated at that time by a semi-Bantu stock (the Akwa), which even yet extends very near to the Efik settlements of Calabar. The Ibo language istelf is not without suggestions of an ancient connection with the great Central African speech which must have been part parent of the Bantu. But it has closer relationships at the present day with the tongues of the Niger-Benue confluence and with the Yoruba-Bini groups.

In the volumes under review—valuable contributions to African ethnology—Mr. Thomas treats of the language in a few general remarks and also in a supplement to his Ibo Dictionary published a year or so ago. This supplement will be most useful to students of African languages. Though I still disagree with Mr. Thomas on some points in his orthography, I am quite in agreement with him as to the way in which he renders the voice tones which are such an important factor in the pronunciation of Ibo and most of the languages of the Niger delta and of the adjoining districts of Dahomé and Togoland. His definition of these tones in the last part of vol. vi. is an admirable treatment of a very difficult subject, which in the hands of previous writers has been rendered so obscurely as to leave the mind of the philologist, not unacquainted with Ibo at first hand, in a state of despairing puzzlement. Volume or "Part" iv. touches also on the question, but deals more especially with religion and magic, social and political organisation, marriage, criminal law, slavery, civil law, agriculture, and trade. It is packed with interest for African students and for ethnologists in general. Part v. comprises the Addenda to the Ibo-English Dictionary, and Part vi. is a collection of Ibo proverbs and stories followed, as already stated, by an essay on the voice tones of the language, an essay which enables one to realise how much music enters into human speech in these more primitive peoples. Conversation in Ibo is always like the recitative in Italian opera, which may be similarly descended through thousands of years from that deep-seated negroid element in the Mediterranean peoples.

The addenda to the Ibo-English dictionary are deserving of study by those who are making researches into African myths and beliefs. I single out one point for comment. The Ibo name is given of the Spitting-cobra, that African cobra which seldom strikes at man directly with its fangs, but by a muscular compression of the poison-bag ejects the venom through the hollow tooth to a considerable distance, aiming generally at the eyes of the person it is striking. The Spitting-cobra was, I believe, first heard of in South Africa through the Dutch colonists in the eighteenth century, and it was regarded for a long time as a zoological fable. During the last twenty or thirty years, however, the fact that this cobra (*Naja haje,* or more likely *Naja nigricollis*) can and does really eject its venom with deliberate aim was attested by the present writer and by many other African explorers, and is now a proved fact. This spitting snake is credited with another accomplishment, not merely in Iboland, but in the beliefs of the natives of East Africa, of Nyasaland, of the Gaboon, the Congo basin, and the Cameroons. It is said to utter a sound like the crowing of a cock. [I have heard this allegation sometimes made in regard to the Tree-cobras, *Dendraspis*.] In Mr. Thomas's Ibo Dictionary the cock-crowing is attributed to the Spitting-cobra, as it is in some other parts of Tropical Africa. It is, at any rate, a curious coincidence that this story should be told of one or other of the cobras in Africa, independently, and without any possible collusion between the Europeans who record these statements. At the same time, I do not know that proof has been adduced that this or any other snake could utter any cry but a hiss. If, however, it is shown that the native stories are true, and that there is a snake in Africa which crows like a cock, it may be at the base of the old Greek stories of the Basilisk. H. H. JOHNSTON.

AMERICAN LECTURES ON MATHEMATICS.

American Mathematical Society. Colloquium Lectures. Vol. iv., "The Madison Colloquium, 1913." (i.) On Invariants and the Theory of Numbers. By L. E. Dickson. (ii.) Topics in the Theory of Functions of Several Complex Variables. By W. F. Osgood. Pp. iii + iii + 110 + iii + 111–230. (New York: American Mathematical Society, 1914.)

Elementary Theory of Equations. By Prof. L. E. Dickson. Pp. v + 184. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 7*s.* 6*d.* net.

THESE works are very different in scope, but may be noticed together as examples of the way in which mathematics is studied in the United States. Prof. Dickson's treatise on the theory of equations is suited for the average university student, and it is interesting to see how an accurate and distinguished mathematician like the author chooses and discusses his topics. He begins with graphics; and here he does what so many fail to do—gives a warning example to show the risk of drawing wrong conclusions from free and easy plotting. Graphical methods are very useful in this theory in connection with such things as Fourier's theorem, Newton's approximation rule, etc.; they are not trustworthy substitutes for calculation when the real roots of a given equation have to be found. Other things dealt with are the elementary theory of cubics and quartics, symmetric functions, separation and calculation of real roots, determinants, systems of linear equations, resultants. The proof of the fundamental theorem for symmetric functions is the proper one: namely, by establishing the one-one correspondence of the highest part of any given symmetric function to that of a definite product of coefficients—not using the theorem about the sums of powers of the roots. The proof that every equation has a root is substantially that of Gauss; this is a rather noteworthy fact. The omission of the Galois theory is quite natural; but we are inclined to regret that the author did not comment on the solutions of the cubic and quartic so as to show their common features, and prepare the way for group-theory.

The same author's lectures in the Madison Colloquium are addressed to experts, and expound what may be called in the first instance a new and amusing mathematical game. Forms and linear transformations are considered, not absolutely, but with reference to an ordinary integral modulus; the result is to change the problem of finding a complete system of covariants and invariants into one of an entirely different character. Connected with this we have a theory of "modular geometry," and in such things as group-study and the study of configurations this seems likely to be of considerable service. The theory is worked out in detail for a quadratic form in m variables to modulus 2.

Prof. Osgood's course is on the very difficult theory of analytical, and in particular algebraic, functions of two or more independent variables. So far as the subject admits, it is an admirably clear and interesting account of the principal results hitherto attained; in particular, those due to E. E. Levi. A remarkable result of recent investigations is to show that a theorem of Weierstrass's about essential singularities is incorrect. It should also be noted how, here and there, the theory of sets of points comes into the argument. Abundant references are given to original sources, and in every respect this course seems to be an admirable guide for those who feel inclined to explore this very important, though thorny and still undeveloped, field.

G. B. M.

CHEMISTRY: PURE AND APPLIED.

(1) *Geschichte der Chemie von den altesten Zeiten bis zur Gegenwart zugleich Einfuhrung in das Studium der Chemie. Vierte Auflage.* By Prof. Ernst von Meyer. Pp. xiv+616. (Leipzig: Veit and Co., 1914.) Price 13 marks.

(2) *Chemistry and its Borderland.* By Dr. A. W. Stewart. Pp. xii+314+11 plates. (London: Longmans, Green and Co., 1914.) Price 5s. net.

(3) *Industrial Chemistry for Engineering Students.* By Prof. H. K. Benson. Pp. xiv+431. (New York: Macmillan Co.; London: Macmillan and Co., Ltd., 1913.) Price 8s. net.

(1) SINCE the date of the first edition in 1888, Prof. v. Meyer's History of Chemistry has been the fullest account of the progress of the science, and most of the present-day chemists owe much of their knowledge of the work of their predecessors to its perusal. In the earlier editions the work of individual chemists was given under their respective names, and it was difficult for the reader to get a clear idea of the development of chemical theory as a whole. In this respect it was inferior to the shorter histories of Wurtz and Tilden, in which the individual workers are mentioned indeed, but their work forms a continuous narrative. In the later parts of this new edition this defect has been largely removed, but without re-writing the whole book it could never be made into a history from which a student could obtain a clear idea of the way in which our present idea of chemical theory had been arrived at. Historians will undoubtedly differ in their estimate of the importance of the several branches of their subject, and probably no two chemists would agree as to the proportion of attention which should be given to any one branch. For instance, it would seem unnatural to many that only three pages out of six hundred should be devoted to Mendeléeff's periodic classification of the elements, the only great generalisation which binds together the otherwise disconnected facts of inorganic chemistry, and that the important additions which Sir J. J. Thomson (spelt Thomsen) has made to chemical science should be dismissed in two lines.

(2) It is difficult to imagine for what class of readers this book is intended. An attempt to teach the final conclusions of a complicated and difficult science in a book of 300 pages, starting *ab initio,* is foredoomed to failure. To the country clergyman who wishes to keep "abreast with the times" it may do no great harm, but it is to be hoped that it will never be given as a prize to a promising schoolboy. A statement like "Inorganic chemistry now includes the chemistry of all the compounds which do not contain any carbon," may be a slip, but the description of the discovery of argon is an untrue representation of the facts. There is a whole chapter on the transmutation of the elements in which the case for transmutation is stated at great length, while the barest mention is made of experiments on the other side. Collie and Patterson have maintained a most praiseworthy reserve as to the conclusions to be drawn from their experiments, and the author would have done well to imitate their reticence.

(3) Of the importance of a knowledge of chemistry to engineering students no one now has any doubt. All the most eminent engineers when consulted as to the curriculum of an engineering school, have emphasised the absolute necessity of the inclusion of an adequate chemical training. In spite of this at least two universities in this country ignore the subject for their engineering students, partly because the authorities consider that the course is already too extended, and partly because it is sometimes difficult to persuade the students of the importance of knowing the character and properties of the materials with which they will have to work. In the best engineering schools, however, the students have a preliminary course of pure chemistry during their first year, followed in the next year by a course of more technical chemistry as applied to engineering. This consists of three principal divisions: (1) Fuels of all descriptions and their modes of application; (2) metallurgy, including the composition and properties of alloys; (3) water in relation to boiler practice, cements and protective materials and coatings.

Prof. Benson has expanded his lectures to engineering students in the University of Washington into the book under review, and judging from it the young American engineer has a chemical training similar to that given to our own students. It is always a matter of difficulty to make a book from lecture notes, and it must be admitted that this one is not free from the defects which are seen in most other books produced in similar circumstances. Most of the descriptions of plant and apparatus are too brief to indicate the way in which the apparatus works, and in many cases a diagrammatic representation would have been much more illuminating than reproductions of photographs of the outside of the machines. Apart from this defect, which would be corrected by a good lecturer, we have nothing but praise for the book. The chapters on hydraulic cements are particularly good, and there is also a good description of industrial alloys.

LIFE AND ITS INTERPRETATION.

(1) *Les Inconnus de la Biologie déterministe.* By A. de Gramont Lesparre. Pp. 297. (Paris: Felix Alcan, 1914.) Price 5 frs.

(2) *Einführung in die Tierpsychologie auf experimenteller und ethologischer Grundlage.* By Gustav Kafka. Erster Band. Die Sinne der Wirbellosen. Pp. xii+594. (Leipzig: J. A. Barth, 1914.) Price 18 m.

(3) *L'Espèce et son Serviteur.* (Sexualité, Moralité.) By Prof. A. Cresson. Pp. 347. (Paris: Librairie Felix Alcan, 1913.) Price 6 frs.

(4) *Life and Human Nature.* By Sir Bampfylde Fuller. Pp. xii+339. (London: John Murray, 1914.) Price 9*s.* net.

(5) *Controlled Natural Selection and Value Marking.* By J. C. Mottram. Pp. ix+130. (London: Longmans, Green and Co., 1914.) Price 3*s.* 6*d.* net.

(1) A. DE GRAMONT LESPARRE makes a very eloquent protest against determinist biology which has no use for the soul. He indulges in not a little sarcasm at the expense of those who regard the psychical life as an epiphenomenon of cerebral metabolism, and hold that physics and chemistry are sufficient, or will eventually be sufficient, for the description of an animal's daily life. He considers sensation, memory, heredity, reproduction, instinct, intelligence, and so on, and shows that the way of determinist biology is hard. Instead of clearing things up, it lands us in an intellectual fog. He will not have anything to say to "psychoids" and the like, but stands for the old-fashioned soul, an active intellectual principle, simple and autonomous, existing alongside of or rather above physiological phenomena. It is well that the difficulties in the way of mechanistic interpretation should be firmly pointed out, and the author's passionate eloquence need not be taken amiss in these days of compromise; it is well to point out the dangers of question-begging phrases like "the life of crystals," and "the memory of a twisted thread"; it is also well to proclaim the inestimable value of the concept of personality; but we think it far from well that one of the author's standing should give in the closing pages of his book an account of the present state of the theory of organic evolution which we do not hesitate to call a pessimistic and reactionary misrepresentation.

(2) Dr. Gustav Kafka has done an admirable piece of work in bringing together in a synoptic, rather than encyclopædic manner, what is known in regard to the senses of invertebrates. It is the first volume of an introduction to animal psychology, and it raises our expectations for what is to follow. The book is clear and scholarly, and it does not lose sight of the wood in studying the trees. It deals with touch, equilibration, hearing, sensitiveness to temperature, to chemical influences, and to light; and ends with "space-sense" (as in homing) and "time-sense" (as in rhythmic movements), though the author admits that these two titles are scarcely justifiable psychologically. The book has abundant and interesting illustrations, but some of them are a little rough. There is a useful, well-selected bibliography. As to the author's general position, he believes strongly in physiology and psychology minding their respective businesses. The physiologist has to work at the series of spatial happenings between the stimulus and the reaction; the psychologist has to work out a subjective description. Just as a chemist would not be warranted in postulating a magician because he did not follow some of the steps in a long and complicated series of reactions, so the physiologist must not postulate a psychoid factor in his nexus between stimulus and response. But the psychologist need make no apology for working out a different kind of description, equally necessary, and certainly not less real. He must keep close to the observed facts of behaviour, but in his psychological account of these he need not allow himself to be too much hindered by the difference between the nervous organisation of the lower animal and that which he himself possesses. There may be analogous psychical life though the anatomical architecture is quite different. A snake can move very effectively, though it has no limbs.

(3) The aim of Prof. Cresson's admirable book is to emphasise the extent to which organisms are adapted for securing the welfare of their race. In their multiplication, in their reproductive processes, in their parental care, individuals do much that is not to their own advantage; their personal interests have been subordinated to those of the species. They are borne on by impulses and instincts which are as compelling as hunger and thirst, but apart from sexual gratification (which applies only to a relatively small number of cases) the fulfilment of these impulses and instincts is often of little individual advantage. Indeed,

it is often fatal. As Goethe said, Nature holds that for the pains of a lifetime it is fair payment to get a couple of draughts from the cup of love. But many animals have not even this, or the psychic reward of seeing the offspring for the good of which they more or less unwittingly spend themselves.

The author illustrates the physiological cost of producing germ-cells, of nourishing the young before or after birth, of parturition, and so on. Many females die of reproduction, and the drone-bees are far from being the only males that are sacrificed on the altar of sex. Many animals, notably insects, spend a very large proportion of their energy in securing the safety of the eggs and the nourishment of the young. In a charming way the author reminds us, in reference to birds, of the work of nest-making, the patience of brooding, the self-forgetfulness exhibited in feeding, cleaning, guarding, and educating the young. For social insects the formula is suggested: "Everything for the species; everything by the individual; nothing for the individual."

What difficulties often lie in the way of the fertilisation of the egg-cell! How much time, experimenting, vital energy, and elimination has gone to the establishment of the structural adaptations, the impelling desires, and the subtler psychical devices which secure this end. There are parallel adaptations of body, emotion, instinct, and intelligence, which secure the welfare of the young. The author has done very valuable service in bringing into prominence the amount of energy expended towards the maintenance of the species rather than towards self-preservation and self-gratification. Animals have become interested organically, if not consciously, in working for the species; they do not know it, but their personality completes itself in the larger life of their race. They may sometimes work under an illusion, but many are enriched and many are pleased; they do not wholly lose their reward. Metaphors apart, variations (probably altogether germinal to begin with), in directions which made for the welfare of offspring, family, society, or species, have been established in the course of selection no less securely than those which made for self-preservation. Metaphors again, this has been Nature's way of setting the seal of her approval on altruistic behaviour, even when the animal's left hand certainly does not know what its right hand doeth.

(4) Sir Bampfylde Fuller's well-written and wholesome book is divided into three parts—the attributes of life; the constraining influences of race, environment and culture; and man's achievements, material, intellectual, and social. Though the most valuable part of the book is probably the third, which gives expression to the author's experience as an administrator, we must restrict ourselves here to the more strictly biological discussion.

What life in essence is we do not know; we must make the same confession in regard to electricity and gravity; but we cannot suppose that life is the result of matter. We must judge of life by its manifestations. Thus changefulness is one—the flux of everyday metabolism, the cyclical development of the individual, the prodigal variability which evolution implies. Another prerogative is effectively responsive sensitiveness, differing from that of a photographic plate in being associated with a more or less clear "awareness." The other attributes on which the author lays emphasis are instinct and consciousness, spontaneity and repetitiveness. We do not think that he states the attributes very clearly, but no two people agree about this, and it is perhaps more important that he writes in a fresh and interesting way about them from a frankly vitalistic point of view. Living creatures are better defined by their impulses than by their organs. "We do not see because we have eyes, but we have eyes because we have an impulse to see." Life is not a series of activities produced by a particular type of substance or machinery, but may be better thought of as a complicated energy of (it may be figured) "interlacing whirls which animates the mechanism of the body, and is not caused by it." The author shows no wavering in his conviction that life transcends mechanism.

(5) Dr. Mottram thinks that he has got hold of a new theory, supplementary to Darwinism. He illustrates it with enthusiasm and with a pleasant frankness, most of his test cases being taken from birds. The theory is that of *controlled* Natural Selection, which seems to mean this:—The variations presented to the sieve of Natural Selection are not all of the same value for the welfare of the species; thus variations in males are not so important as variations in females, for males are less valuable than females; and one set of variations is more liable to be selected than another, challenging criticism more, as it were. Thus what Natural Selection effects is in a sense "controlled" by the nature or value of the variations that are forthcoming. What truth is there in this? If we compare the action of Natural Selection to that of a pruning knife, and liken variations to the new growths of a tree, we may say that the final result is a function of the growth on the one hand and the pruning on the other. But the phrase "controlled selection" is surely misleading. Then again, as

to value, some new departures are certainly of more value than others, but the value is relative, not absolute; it is in relation to the particular exigencies of the species. We agree with the author that a variation may be established, though it is not of individual value; thus, as Darwin clearly stated, a variation in the direction of greater parental care may become a race-saving specific character, but its value is always in relation to particular conditions of life, *i.e.* in relation to the selection that goes on. To say that Natural Selection is thus controlled is arguing in a circle.

Dr. Mottram has an excellent chapter on the values of conspicuousness, whether of movement, form, sound, scent or colour; and he has the courage to uphold the thesis—the converse of Wallace's—that "the male becomes brilliant in colour in order that he may be more likely to be destroyed: and thus the dull-coloured female gain protection"! This would naturally lead to the elimination of the more brilliant males, but fortunately they mate before they are killed, so that their brilliant qualities are handed on! It would be equally easy to suggest that the character which is established is not merely conspicuousness, but conspicuousness plus such agility that the gay fellows are never caught. We think that the author should re-consider his theory. As a lover of birds, by the way, he should not have passed such a large number of disfiguring misprints in their proper names—we counted ten without looking for them.

OUR BOOKSHELF.

Clean Water and How to Get It. By Allen Hazen. Second edition, revised and enlarged. Pp. xii+196+plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 6*s*. 6*d*. net.

WE are glad to see a second edition of Mr. Allen Hazen's useful little book on water purification. There are still the interesting chapters describing the various sources of supply and methods of purification, and considerable space is devoted to the problems arising from the tastes and odours developing in water through stagnation and the growth of organisms. Other chapters relate to statistics of supply in different cities, and suggestions are made as to the relative sizes of the several parts of a water works which would be useful in designing a new supply.

New chapters have been added dealing with the "red water" problem, and with the disinfection of water supplies, and it is unfortunate that, with regard to the latter question the author has not gone into the subject more fully, as it is a question which has recently received a great deal of study, both in this country and more particularly in the United States.

Two omissions immediately occur to the English reader, the first being that the author fails to recognise the pioneer work done in this country by Dr. Houston and others on the use of hypochlorites as sterilising agents, and does not mention at all that the first time these substances were used on any considerable scale was at Lincoln in 1905, when in consequence of a serious epidemic of typhoid fever the whole of the water supply was continuously sterilised with sodium hypochlorite by Dr. Houston for more than a year with remarkable success.

The other point is that no mention whatever is made of the now well-known "excess lime" method of sterilisation of Dr. Houston, which was first described by him in 1912 in his reports to the Metropolitan Water Board, and has since been successfully applied to several water supplies both in this country and in the United States.

The book is well illustrated with photographs, and is worth a place on the bookshelf of everyone engaged in the scientific study of water supply. D. B. B.

The Vaccination Question in the Light of Modern Experience: An Appeal for Reconsideration. By Dr. C. K. Millard. Pp. xviii+243. (London: H. K. Lewis, 1914.) Price 6*s*. net.

DR. MILLARD'S book is carefully and well written, and with authority; and the general plan of it is very good. He believes, absolutely and profoundly, in the power of vaccination to safeguard each of us against smallpox; and he is outspoken, as he ought to be, over the folly of all who deny this fact. But he feels, very strongly, that the "Leicester experiment"—the rigorous constant notification, isolation, surveillance of contacts, sanitation, emergency vaccination, and so forth—has been a success, not a failure. He points out, very truly, that the danger is less from severe cases than from slight, "masked," unrecognised cases; and these cases often occur in persons lightly and inadequately vaccinated to satisfy the law. He tells the dreadful story of Dewsbury and of Gloucester, where the people had Leicester's anti-vaccination spirit without Leicester's sanitation. The main purpose of his book is to underline the difference between vaccination as a personal safeguard and vaccination as a civic safeguard.

The whole book is of singular interest. It is open to criticism here and there. The author does not lay enough stress on the fact that evil or fatal effects from non-aseptic vaccination belong, nearly all of them, to a time which is happily over and done with. He does not sufficiently reckon with the chance of contact cases escaping from surveillance and flitting outside the cordon. It may be, also, that he ought to make more allowance for the possible surprise of the disease flaring up with unexpected virulence of type: we must be very careful how we talk of a disease "dying out." Still, here is a book well worth buying and studying. The illustrations and diagrams are admirable; and Dr. Millard has not only authority, but an excellent style.

Bibliotheca Geographica: Jahresbibliographie der Geographischen Literatur. Edited by Joseph Müller. Band xviii. Jahrgang, 1909 und 1910. Pp. xvii+483. (Berlin: W. H. Kuhl, 1914.)

ASSOCIATED for many years with the name of Prof. Otto Baschin, this excellent publication is as useful as ever under its new editor. In previous issues the "Bibliotheca Geographica" purported to be a bibliography of *all* geographical books and articles that appeared; the current issue is limited only to scientific writings. And the list of them runs to 480 pages! The student will find in the catalogue all manner of books and studies in learned journals bearing on the many-sided problems of geography, not omitting methods of teaching. Turn, for instance, to the section on Austria-Hungary. Books on physical geography, cartography, climatology, mountains, hydrography, biological geography, historical geography, and last, but not least, maps are mentioned. The diligence of the editor deserves all praise, and his book should prove of great use generally, more especially in countries like Russia, of which the language is a sealed book to most. In many cases, immediately after the entry of a particular book, stands a reference to a review of it. Thus, following Mr. A. L. Salmon's "Dorset" in the "Cambridge County Geographies," we have a reference to the *Geographical Journal*, vol. xxxvi., p. 178, where the book is noticed. This additional information is certainly useful. But it does not go far enough. If only we had some indication in these long lists of books of their relative value (even in a very general way) the "Bibliotheca Geographica" would add much to our indebtedness.

Science and the Miller. By J. S. Remington. Pp. 166. (Liverpool: The Northern Publishing Co., 1914.) Price 4*s*. 6*d*. net.

ENGLAND is justly proud of its milling industry, and the advances made in it both on the mechanical and the technical side during the last decade have given the lead both to Europe and America. Our biggest milling concerns are already willing to learn, and there are indications that the smaller miller, too, is prepared to accept the help that applied science will give him. It is essential, however, that his chemist should be of the right type; such, for example, as is portrayed in the work under notice. The chapter on the training of the flour-mill chemist is an admirable statement of what is necessary, whilst the remarks as to the position the employer should take towards the chemist will be applauded by every man of science with works experience.

Later chapters give hints as to the directions in which the chemist can make himself useful in the mill, and from these we would select that on improvers and enrichment processes for special commendation. This question is imperfectly understood, and has formed the point of attacks by ignorant food reformers in the public Press, who would do well to study Mr. Remington's book.

Lengthy sections of the work are devoted to breakfast, invalid and infant foods, and to the more prosaic subject of feeding cakes and offals. The disposal of residues, such as are made into compound cakes, is a most important consideration to both the flour and oil miller, and it is to be regretted that the average farmer does not yet fully understand the many virtues of the scientifically compounded cake.

Impurities of Agricultural Seed, with a Description of Commonly Occurring Weed Seeds and a Guide to Their Identification. By S. T. Parkinson and G. Smith. Pp. 105+xxxviii plates. (London and Ashford (Kent): Headley Bros, n.d.) Price 3*s*. net.

THE authors of this little book express the hope that it will be of practical use to farmers, seedsmen, teachers and students. This hope will, we believe, be fulfilled, but we hold that had the volume been prepared for a less mixed community it would have been more specifically useful. As it is, the first thirty or forty pages are taken up with generalities—so beloved by the present-day teacher—which, if they are included at all, should come as savouries and not as *hors d'oeuvres*. Farmers know well enough that weeds are bad, and if the main object of the authors is to help farmers to judge of a sample of seed, they might well relegate to an appendix their description of the harm done by weeds, and bring into first place the excellent descriptions and illustrations which now occur in the latter half of the book. These descriptions might also be so adjusted as to occur in all cases opposite the photographs.

Discussion of questions on such subjects as national seed-testing stations and State legislation with respect to weeds might, we think, be omitted altogether, and the space saved filled to better purpose by weed-analyses of actual samples of bought-in seeds, by lists of weeds characteristic of different types of soil, and by notes on the respective appearances of new and of old and "treated" seed. In short, if the authors in preparing a second edition will forget the teacher and the student in agricultural colleges, and think of the farmer—the seedsman can look after himself—they will add to the utility of an already useful little book. The more so if they can persuade the publishers to reduce the price to a shilling.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Enhanced Series and Atomic Models.

IN the Bakerian Lecture, "Series Lines in Spark Spectra," Prof. A. Fowler indicates an explanation on Bohr's theory of enhanced series in which the Rydberg constant is 4N instead of N. It may be of interest to point out how the model atom described in my paper (*Phil. Mag.*, December, 1913) would be capable of emitting similar series. This atom can be shortly described as a rotating Thomson atom, capable of executing elastic vibrations. If the negative electron is constrained to remain on the surface of a sphere of radius r within the atom (radius a), it will have a frequency v given by the formula $v=A-N(r/a)^2$, where A depends on the boundary conditions, and the homogeneous radiation emitted will be of amount hv, where h is the quantum constant.

Reasons are given in the paper for showing that if the atom were executing radial vibrations the electron would be imprisoned on a nodal sphere and usually on the smallest nodal sphere of a given mode. Thus if the radii of the nodal spheres were given by the formula $r=a(n/m)$, where n and m are integers $(n<m)$, then in the formula for r we take for a series $n=1$ and $m=3, 4, 5, \ldots$ For the enhanced spectra it is only necessary to suppose that the electrons may be on the second nodal sphere of each mode, *i.e.* putting $n=2$.

ARTHUR W. CONWAY.

Elsinore, Dalkey, Co. Dublin, October 1.

Theodore Schwann and the University of Louvain.

IT might not be altogether inappropriate at this time when the world of true culture is grieving inconsolably over the destruction of the University of Louvain, to be reminded that the originator of the famous cell-theory, Theodore Schwann (1810–82), was for nine years a professor at that University. To biologists this fact is probably the most interesting association which the mention of Louvain arouses. Schwann went to Louvain as professor of anatomy in 1838, and left it for a chair at Liège in 1847. It was in 1839 that he gave to the world the cell-theory in a treatise, "Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants," as the title runs in the translation made by Henry Smith in 1847 for the Sydenham Society.

This great generalisation was made public, therefore, while Schwann was in his chair at Louvain. It is perhaps not so well known that after he had been seven years at Liège, he invented a self-contained respiration apparatus in which carbon dioxide was absorbed and oxygen liberated. It was the precursor of the rescue apparatus so much used in coal mines at the present day, for Hales's apparatus (1726) was too crude to have been of any real value.

It is interesting to know now that, through a crime no expiation can ever atone, the University of Louvain is no more than a memory, its name will be associated with one of the most far-reaching generalisations ever made in the nature of living things—the cell-theory of Schwann of Louvain. D. FRASER HARRIS.

Dalhousie University, Halifax, N.S.,
September 18.

Filtering Power of Sand.

To those who wish to repeat the experiments on the filtering power of sand, mentioned by Prof. Trouton at the recent meeting of the British Association, I would strongly recommend a solution of the aniline colour known as "Nachtblau." A strongly coloured solution of this substance passed through Fontainebleau sand issues from it absolutely colourless for a much longer time than does that of potassic permanganate. C. J. WATSON.

The Midland Institute, Birmingham, October 1.

FLIGHT OBSERVATIONS IN INDIA.[1]

VARIOUS theories have been proposed by different writers to account for the fact that birds are able, in certain countries, to remain suspended or even rise in the air without any apparent exertion and without flapping their wings. This action appears to have become known as "soaring flight," notwithstanding the fact that in two English dictionaries now before us the verb "soar" is defined as meaning to rise in the air, without any reference to the means adopted. On the other hand, the action in question does not necessarily imply rising, but it may exist equally when a bird maintains the same level for an indefinite time. We prefer to describe this action as "sailing flight."

Now while writers innumerable have attempted to offer explanations of this apparently paradoxical phenomenon, very little has been done to obtain systematic records, extending over long periods, of the conditions under which soaring or sailing flight takes place. This is probably due to the fact that in northern Europe, where most scientific work is done, sailing flight rarely occurs. During his residence at Agra, Dr. Hankin has had specially favourable opportunities for observing large birds in sailing flight, and his present record of observations should do much to systematise our knowledge of the subject.

The principal birds which figure in Dr. Hankin's observations are as follows:—

	Span in feet.	Load in lb. per square foot
Cheel (*Milvus govinda*)	4 ...	0·55
Scavenger (*Neophron gingianus*)	5 ...	0·87
Common Vulture (*Pseudogyps bengalensis*)	7 ...	1·13
Black Vulture (*Otogyps calvus*)	6·5 ...	1·23
Adjutant (*Leptoptilus dubius*) ...	9–11 ...	1·54

Dr. Hankin distinguishes a number of different sailing actions, some of them continuous, others alternating with flappings of the wings. These he designates by such names as ease circling, flap circling, flap gliding, flex gliding. A large portion of the book is occupied with illustrated descriptions of the positions of the wings, tail, and body in different kinds of flapping and sailing flight (*cf.* Figs. 1, 2, 3).

The principal theories that have hitherto been advanced attribute sailing flight to irregularities in wind velocity (*cf.* Langley's "Internal Work of the Wind") or upward air currents (Maxim and others). Dr. Hankin attempts to prove that neither of these causes is sufficient to account for the phenomena as they occur in India, and that the explanation must be sought in some other unknown cause. In particular he uses the term "soarability" to designate the state of the atmosphere when sailing flight is possible, and so far as his observations tend to define when and under what conditions this state exists, they constitute a first step in the solution of the problem.

Now Dr. Hankin observes that in fine weather there is a definite time in the morning, varying from day to day, at which sailing flight commences. Unfortunately, however, he gives very few observations as to the time when it ceases, and in this connection further records are needed. It would be very much more conclusive if he had plotted curves showing the number of sailing birds of different kinds observed during different hours of the day, in the same way that examiners plot curves showing the number of candidates who gain different percentages of marks. In any case, he has fully established the fact that "soarability" commences at a time when the sun's rays are beginning to warm the earth. Furthermore, the sailing flight of these large birds only occurs at a certain height above the ground, which is greater the heavier the bird. In the case of circling flight there is not much difficulty in attributing the effect to localised upward convection currents. Such currents would naturally start at a definite instant, when the equilibrium of the atmosphere had become unstable owing to the heating and consequent expansion of the lower layers. But Dr. Hankin considers that this explanation is ~~not~~ able to account for a certain form of sailing flight which he describes as "flex gliding" (*cf.* Fig. 4).

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[1] "Animal Flight," a Record of Observation. By Dr. E. H. Hankin. Pp. 405—Index. (London: Iliffe and Sons, Ltd., n.d.) Price 12*s.* 6*d.* net.

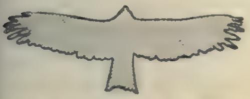

FIG. 1.—Outline of a cheel curling.

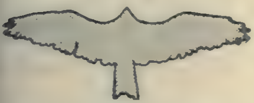

FIG. 2.—Outline of a cheel with wings slightly flexed, as seen in flex-gliding at low speed.

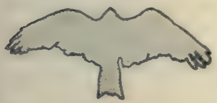

FIG. 3.—Outline of a cheel with wings strongly flexed, as occurs in fast flex-gliding.
From "Animal Flight."

The peculiarity of flex gliding is that the bird glides uniformly in a straight line without loss of height, and that a number of vultures may be seen simultaneously flex gliding in different directions. If the energy required were supplied by *localised* air currents, these would affect the motion or the positions of the wings, and Dr. Hankin finds that this is not always the case.

But it must not be forgotten that the expansion of the lower layers of the atmosphere caused by the sun's heat necessarily tends to lift the upper layers as a whole, so that, apart from all convection currents, there must be a general upward movement which increases with the altitude, even though there is not a breath of wind at the surface of the earth. A bird gliding downwards with a *relative* velocity of which the vertical component is equal to that of the ascending air would perform a horizontal flex glide.

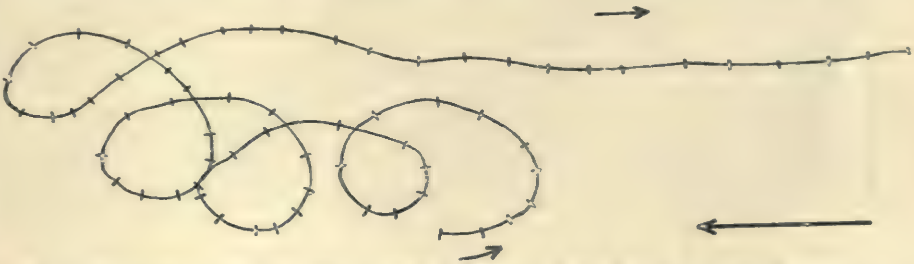

FIG. 4.—Cheel circling and then flex-gliding up-wind at slow rate. At the time there was thin cloud and no fast flex-gliding had occurred. A few minutes later as cloud got thinner, fast flex-gliding of cheels began. Track marked at 1 sec. intervals. Wind at the time not strong enough to move leaves. From "Animal Flight."

From a purely qualitative point of view this explanation exactly fits the circumstances of the case. The cause must necessarily exist under exactly the conditions under which the effects have been observed. The only question is whether the upward motion is sufficient.

Without specifically considering this particular kind of upward motion, one of Dr. Hankin's main objections to any hypothesis of the kind appears to be based on his observation that in fast flex-gliding the quill feathers are bent forward, and that in order to bend them a considerable force, sometimes amounting to 150 grams on a single quill, is necessary. For this reason Dr. Hankin asserts that "sun energy" must be capable of producing a pressure on the wings determined by this force. But he does not adequately discuss the conditions of equilibrium, which require that, for uniform motion, the forward pressure on the wings must be balanced by an equally large head resistance. It is futile to try to explain the action on the wings without accounting for the equal and opposite reactions on the bird's body.

The attempts which Dr. Hankin makes to deal with these statical and dynamical considerations cannot be regarded as altogether satisfactory. In the preface he claims to have avoided the use of technical terms. So, indeed, have many other writers of books on flight, but the mistake is when they substitute something far worse. This book contains several instances of the misuse of the principles and nomenclature of theoretical mechanics. For example, on p. 208 the author finds that there are four chief forces acting on a bird commencing gliding, namely, the pull, the drag, the lift, and the weight, and he says: "The pull consists of the momentum of the bird. This acts in a horizontal direction at the centre of gravity." On the next page he makes the drag and this momentum form a couple "that tends to rotate the bird upwards round its transverse axis—in other words that tends to maintain the angle of incidence." Such an unbalanced couple would increase, not maintain, the angle of incidence, as he himself shows elsewhere.

Not contented with confusing momentum and force, the author says, on p. 206, "Thus we have arrived at the conclusion that in flex gliding the sun energy stored in the air acts as a constant force."

It is also a pity that the known term "instability" is used to denote rotations which he evidently considers are often due to atmospheric disturbances rather than to the wings being held in an inherently unstable position. In any case, these rotations could certainly be described as lateral, longitudinal, and directional better than by the suggested names of lateral, transverse-axis, and dorso-ventral axis instability.

However, it must be remembered that this book only claims to be "a record of observations." Dr. Hankin has clearly established the fact, whatever be the explanation, that "sun soarability" must depend on peculiar meteorological conditions which do not exist in temperate climates. As a number of chairs of physics have recently been filled in Indian universities, we may hope that some of the recipients may investigate these conditions, and we must not forget that Dr. Hankin's observations have mainly referred to the *birds* rather than to the *medium* in which they sail.

Further, he has not by any means restricted his attention to the large Indian sailing birds of prey. Gulls, dragon-flies, flying fishes, all come within the scope of his observations, and not the least interesting feature is the difference in action between different species of dragon-fly. That aeroplanes require a greater degree of camber for low than high velocities is a well-known and obvious truth, and the observation that birds can adjust the camber to the speed is highly interesting.

In one chapter are described certain remarkable colour-phenomena noticed in sailing flight. It is, of course, very difficult to judge of such matters by reading descriptions, but it may be safe to refer to similar colour effects which were shown some years ago in "Benham's Artificial Spectrum Top." This consisted of black and white discs with black bands on them, and was exhibited at Cambridge about the time that Dr. Hankin was a Fellow of St. John's.

In conclusion, this "record of observations" forms a worthy sequel to the works of Pettigrew, Marey, and other previous writers. G. H. B.

THE ANTIQUITY OF MAN IN EUROPE.

AMONGST the many services which Dr. Robert Munro has rendered to anthropology during a long and strenuous career, the appearance of this work by Prof. James Geikie is not the least. Dr. Munro founded a lectureship on anthropology and prehistoric archæology in the University of Edinburgh, which Prof. James Geikie was invited to fill. In this book the Munro lectures, containing the ripe experience of the foremost student of the "Ice-age," are placed at the disposal of archæologists and anthropologists all the world over.

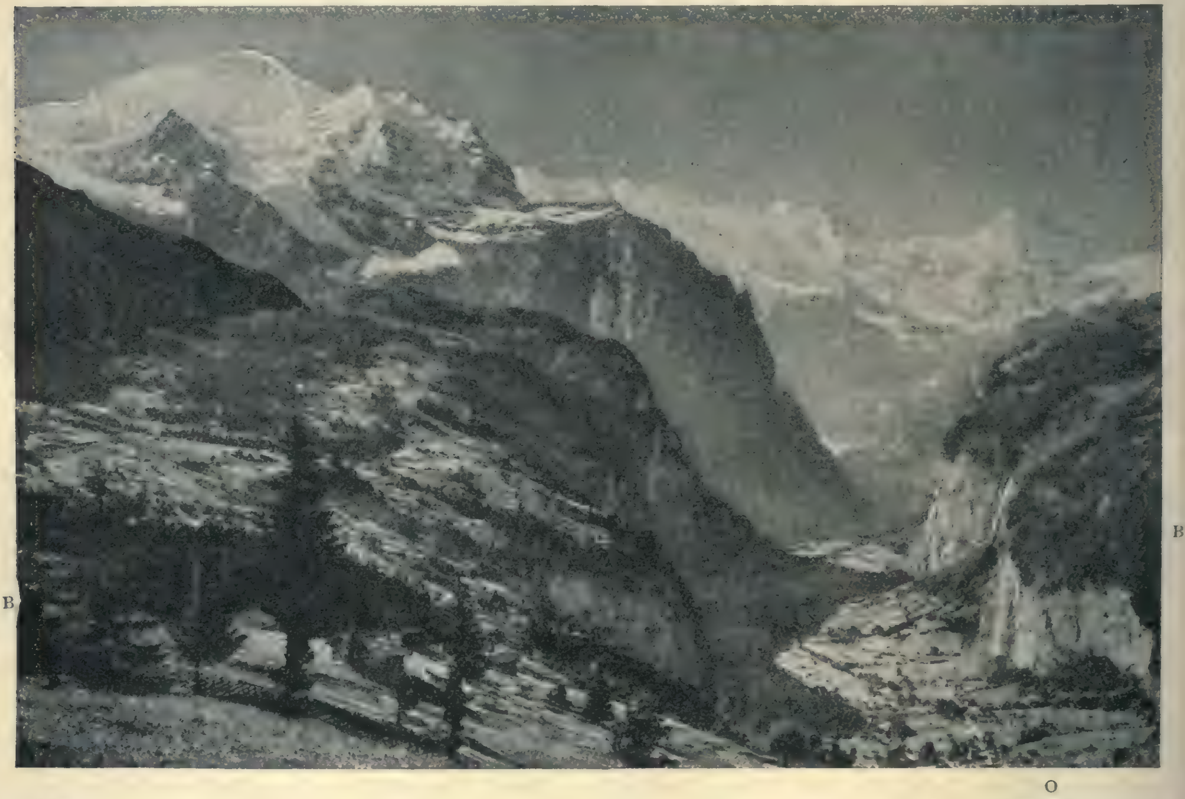

Photo. *Photochrom. Co., Ltd.*

The Lauterbrunnental. Switzerland. B, B, Bottom of Preglacial Valley; O, Trench excavated by Glacier-ice. From "The Antiquity of Man in Europe."

It is said that British men of science are inclined

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[1] "The Antiquity of Man in Europe: being the Munro Lectures, 1913." By Prof. James Geikie. Pp xx+328+xxi plates. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson, 1914.) Price 10*s*. 6*d*. net.

to accept discoveries and classifications made abroad more readily than those made at home. The terms at present employed in British archæological works relating to the phases of the Ice-age certainly might be cited in support of this contention. In 1894, when preparing the third edition of the "Great Ice Age"—of which the work under review may be regarded in some respects as a fourth edition—Prof. Geikie recognised four phases of glaciation, which he named: (1) Scanian, (2) Saxonian, (3) Polonian, (4) Mecklenburgian. British students of ancient man have never adopted these terms; they prefer those which Prof. Penck introduced nine years later—in 1903—(1) Günzien, (2) Mindelien, (3) Rissien, (4) Würmien. Geikie's terms were founded on a study of the glacial deposits of Europe generally; Penck's were the result of a study of glacial deposits in Alpine regions. If priority is to count the British terms have much to commend them. In the present work Prof. Geikie correlates the two systems of nomenclature—the "Scanian" corresponding to the "Günzien," the "Saxonian" to the "Mindelien," the "Polonian" to the "Rissien," and the "Mecklenburgian" to the "Würmien."

In charting the glacial phases of the Pleistocene period, Prof. Geikie and Prof. Penck have provided students of ancient man with an invaluable series of milestones to guide them into that period which is supposed to cover the evolution of modern man. The Heidelberg mandible is regarded by Prof. Geikie as the oldest human remains yet found on the Continent of Europe, and is assigned by him to the interval between the first and second periods of glaciation. He is not fully convinced that eoliths and sub-crag implements are really of human workmanship.

One of the most important contributions made by Prof. Geikie to our knowledge of ancient man refers to the Neolithic period. In the formations and deposits of that time Scotland is particularly rich. From a study of these he has divided the Neolithic period into four phases: (1) lower "forrestian," (2) lower "turbarian," (3) upper "forrestian," (4) upper "turbarian." Each of these phases is marked by a change of climate, a change of flora, and an alteration in the relationship of land and sea. The human remains and objects of culture found in the caves at Oban, usually ascribed to the transitional stage, between the Palæolithic and Neolithic periods, are regarded by Prof. Geikie as belonging to the late Neolithic phase, named up him upper "turbarian."

Prof. Geikie has never indulged in, or countenanced, wild speculation. It is therefore of interest to note the estimate he has formed of the duration of the Pleistocene period. After forty years of study, largely devoted to an examination of glacial deposits, he is of opinion that an allowance of at least 600,000 years must be made for the duration of the Pleistocene period. Man's presence in Europe may, in his opinion, be regarded as extending over a period of 250,000 or perhaps 500,000 years.

A. K.

THE CULTIVATION OF MEDICINAL PLANTS IN ENGLAND.

THE question has been asked whether the conditions created by the war in Europe has made it desirable to give attention to the cultivation of medicinal plants in England. The answer is a decided affirmative, but some qualification is needed. Cultivated drugs can never compete with those from wild plants if price prevails over all other considerations. It was only fine appearance and high reputation for therapeutic activity which enabled English aconite, belladonna, digitalis, and henbane to command four times the price of the imported drugs. As it was, severe competition had of late years restricted the use of home produce more and more until it attained relatively small limits.

Much care and skill are needed in preparing the finest qualities of drugs for market, and only comparatively high prices repay this initial trouble and expense. Again, there is only a limited outlet for drugs in general, so that the market is easily overloaded, and when this occurs the highest grades often suffer most as regards depreciation in value. For example, the supply of English-grown belladonna leaves began to exceed the demand in about the year 1900, and a few years ago they were selling in competition with wild Continental drugs—at less than cost. Acreage under belladonna naturally shrank, and, in fact, its cultivation became restricted to a few "materia medica," or drug farms, connected with factories for making extract. Similar experiences led to the cultivation in England of all but a few medicinal plants (*e.g.* valerian, poppy, and dill) being controlled by four firms growing only sufficient for their own requirements. Two successive wet winters, causing excessive loss of plants, had made this season's crops insufficient for normal demands, and the onset of hostilities quickly raised prices to famine rates. High prices restrict usage and stimulate new sources of production until prices become normal again. Both these factors are at work now war in Europe threatens to last for a considerable period, and the first in the field of drug cultivation are likely to reap a profitable harvest.

The writer gave details of cultivation of various drugs in the Journal of the Board of Agriculture for September. Within a week an advertisement in the druggist's trade paper "wanted fertile seeds of belladonna, digitalis, henbane, stramonium; also live roots chamomile, coltsfoot, valerian, spearmint." This illustrates a great initial difficulty, that of obtaining a supply of dormant plants or seeds.

British medicinal plants fall into four categories:—

(1) Drugs which have long been cultivated in this country, but were gradually being ousted by foreign wild products, viz. belladonna, henbane, aconite, digitalis, and valerian. All these, except aconite, are now in great demand. Chamomile (of recent years practically grown only for distillation of oil from flowers) are now almost unob-

tainable owing to Belgian supplies being cut off. Of other aromatic plants grown for distilling purposes, peppermint is not likely to be affected, but spearmint and probably lavender will be dearer. Efforts to extend drug growing will centre around belladonna, henbane, valerian, and chamomile. The first year's returns as regard size of crops will be small, but they will increase rapidly afterwards if remunerative prices are maintained.

(2) Medicinal plants which held their own in competition with foreign supplies:—Dandelion, dill, white poppy, and red poppy petals. Of these the first and last grow wild. The second is as easily grown by farmers as cereal crops. Poppy-head production is a special industry in Lincolnshire. Many of the "botanical herbs" sold by medical herbalists are grown at Carshalton, Surrey, but not in sufficient quantities to supply all home requirements. There is undoubtedly much greater scope at present for the cultivation of medicinal plants in this category. Culinary herbs (marjoram, sage, thyme, etc.) are also worthy of attention.

(3) Plants which grow wild, but are not collected in quantity in this country under normal conditions:—Barberry bark, bittersweet, broom, buckthorn berries and bark, colchicum, coltsfoot, conium, elder flowers and leaves, male fern, rose petals, sweet flag, and yarrow. Considerable sums could be made by organised collection of these (and also of wild dandelion root and digitalis leaves). The most promising from a money-making point of view is male fern rhizome, of which large quantities are needed at once. There is plenty in many localities to be had for the gathering.

(4) Medicinal plants rarely cultivated in this country, but worthy of more attention:—Golden seal, fennel, and thornapple. The last two are easily grown, and in much demand now. The first-named promises rich reward to the successful experimenter.

Fig. 1.—A plantation of English Valerian (*Valeriana officinalis*, L.). From the Journal of the Board of Agriculture, By permission of H.M. Stationery Office.

Most medicinal plants belong to the category of weeds, so that they are not difficult to raise if the ground is kept free from other growths. It is the need for having some facilities for drying leaves and roots that may prevent medicinal herbs being grown by cultivators of other crops as a paying side-line. Medicinal leaves are valued solely by appearance, this being brighter the more quickly they are dried. In the case of potent drugs, such as belladonna and digitalis, it is imperative that the leaves do not become "heated," this being prevented by spreading in very thin layers. Large growers of drug products have proper drying plant, but a heated glasshouse could be readily converted into a drying shed.

The labour problem is another great hindrance to cheap supplies of British-grown medicinal plants. On the Continent wild plants are collected at odd times usually when harvesting is over. On English drying farms the crops are taken when plants are at their best, the time of collection having in some cases an important influence on the therapeutic effect of the drug. This point is fully recognised in the theory of medicine, but in practice it is usually lost in the modern craze for "cheapness." The cheeseparing policy at times defeats its own object, as the proportion of actual drug in a dose of medicine is so small that doubling the cost of crude drugs would make little or no difference in ultimate cost. A ten-minim dose of digitalis tincture from British-grown drug costs 1/500th penny more than that from imported drug, quite a negligible quantity in comparison with the greater certainty of action.

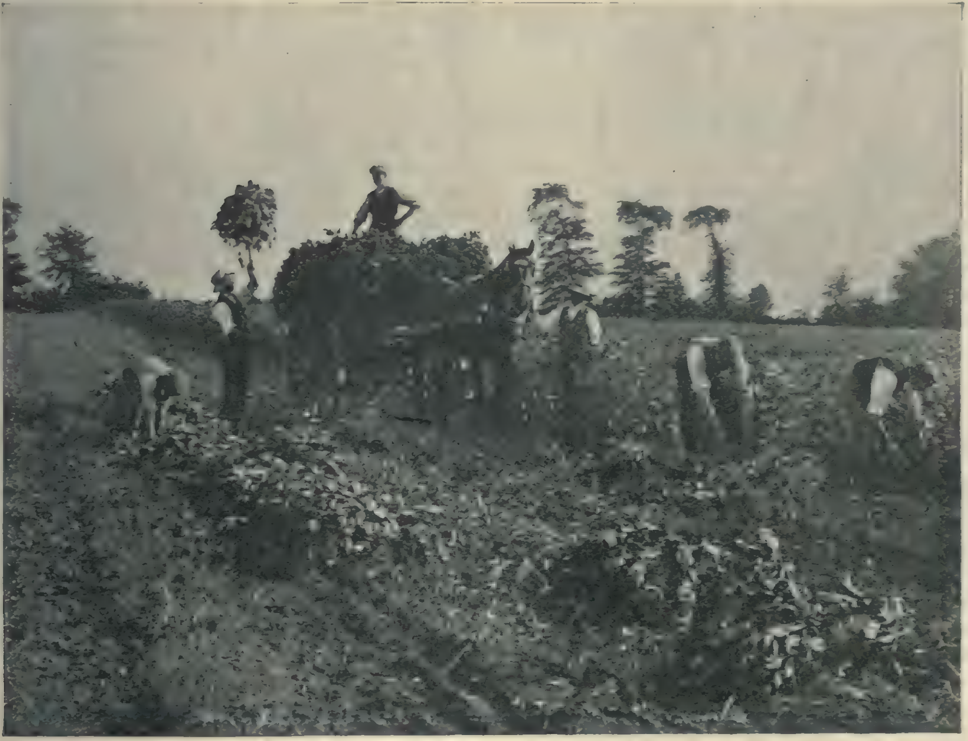


FIG. 2.—Cutting English belladonna. (*Atropa belladonna*) From the Journal of the Board of Agriculture. By permission of H.M. Stationery Office.

The drug trade is likely to regret bitterly for some time to come the policy which led to the virtual exclusion of home-grown drugs. A considerable extension of the acreage under medicinal plants will result from the conditions created by the European war. When this is over and foreign supplies are again available it is to be hoped that druggists, wholesale and retail, will give that moral and patriotic support needed to prevent it again relapsing.

W. A. WHATMOUGH.

THE BRITISH ASSOCIATION IN NEW SOUTH WALES.

SYDNEY, AUGUST 27.

THESE lines are written a few hours after the departure of our visitors for Brisbane, where two addresses will mark the conclusion of the first Australian Meeting of the British Association. When the shadow of this cloud of war has passed away, the Australian Meeting will stand out as a notable one. Its total of 4700 members is about 1000 greater than that of any other meeting. Much solid work has been done in the various sections, while great public interest has been aroused by the lectures and addresses. Those who believed that the outbreak of war would have a serious effect upon it have learned that their fears were groundless. Though the minds of all have been filled with anxious thoughts of what may be happening to our soldiers and sailors far away in this crisis of the Empire's fortunes, on all hands there is ample evidence that the meeting has been an unqualified success.

On Thursday, August 20, our visitors arrived from Melbourne, about 10 a.m., in three special trains, and the arrangements for their speedy transit to the houses of their hosts worked admirably. Early in the afternoon the Reception Room at the University began to be thronged with members inquiring for their various tickets, and anxious to secure places in the excursions without delay, which had been arranged for the week-end.

The President delivered the second half of his address in the Town Hall that evening. With a more than considerate regard to the traditional, if somewhat mythical, rivalry between Melbourne and Sydney, Prof. Bateson had divided his address into two equal parts, and the Sydney members had the privilege of listening to that half in which he discussed problems of heredity more especially as affecting man. The importance of the occasion was marked by the presence in the chair of the Governor, and the Lieutenant-Governor proposed the vote of thanks which followed the lecture. Probably to many in the large audience the literary beauty of the address was as remarkable as the startling statements with which it was punctuated; while Sir Edward Schäfer, in seconding the vote of thanks, gave it as his opinion that we had listened to a deliverance which was epoch-making.

On Friday morning the meetings of the sections were resumed, and the remaining sectional presidential addresses delivered. The presence of Sir Oliver Lodge and Sir Ernest Rutherford attracted large audiences to the Mathematical and Physical Section throughout the meeting. The Geological Section was popular, especially on the last day of the meeting when Sir Douglas Mawson, who had just returned to Australia in time to be present, opened the discussion on Antarctica. The section of Anthropology had most carefully stage-managed the production of the Darling Downs Skull. This discovery, and the presence of Prof. Elliot Smith, Prof. von Luschan, and other anthropologists, attracted large audiences to Section H. And, finally, it is scarcely necessary to remark that, under Prof. Perry's guidance, the meetings of the Educational Section were both lively and well-attended. But so much was heard of the tyranny of the ancient languages that it is whispered that at least one educational authority thought that the time had come for a sub-division of Section L, in order that the friends of Latin and Greek and the Humanities might have an opportunity in calmer surroundings of attempting to solve educational problems in their own way.

I have already spoken of the impression made by the President's address. The two evening discourses were given by Prof. Elliot Smith and Sir Ernest Rutherford. The former was back among his own people; and the huge audience which listened to his address showed that his countrymen were proud of him and of his work. In discoursing on Primitive Man on Friday, he gave special prominence to the discovery of the Darling Downs Skull, announced to the Anthropology Section that morning, by Profs. David and Wilson. It seems probable that this event alone would be sufficient to make the Australian meeting memorable. The second discourse was delivered by Sir Ernest Rutherford in the beginning of the week, also to a large audience. He chose as his subject Atoms and Electrons. Sir Ernest Rutherford, also, was back among his own people, for though the New Zealander is not an Australian, both are Australasians; and it was remarkably appropriate that the honour of giving these two discourses should have been awarded to these two men.

The Citizens' Lectures were delivered under the auspices of the Workers' Educational Association; the first, by Prof. Benjamin Moore, on the Saturday evening. He dealt more particularly with the principles of evolution, both in things organic and inorganic. After demonstrating the operation of bright sunshine on brown earth, he described how the process of evolution is everywhere at work, transforming both nature and society. Prof. Turner, on the Tuesday evening, spoke upon Comets to an audience of more than 3000 people. By accident—or it may have been by design—both these speakers proved to be hearty supporters of the Workers' Educational Association, and the audiences fully appreciated their cordial references to this movement.

The luncheon, which the State Government gave in honour of the Association on Friday, was a most interesting function. The oration by the Premier and the reply by the President of the Association were most remarkable deliverances. The other social events of the week were the garden party at Government House, an afternoon excursion in the Harbour, and the Lord Mayor's ball. There was some talk of this last function being changed into a reception, owing to the special circumstances of the meeting, but to those with whom the decision lay it seemed best that the original programme be carried out. There can be no doubt that all these events added greatly to the enjoyment of the members. Elaborate preparations had also been made for a conversazione at the University on Tuesday evening, at which degrees were to be conferred on some of our distinguished visitors. However, owing to the death on the previous day of the Chancellor of the University, the Hon. Sir Normand MacLaurin, one of the greatest men whom this country has produced, this function was cancelled. The degrees will be conferred *in absentia*.

The excursions arranged for the week-end proved most successful. The members were scattered over a wide range of country. Some, interested in agriculture, were shown what was being done under varied conditions in different parts of New South Wales. Geologists were taken over the coal fields of the Lower Hunter. Engineers visited the Burrinjuck Dam and the Murrumbidgee irrigation area. Botanists saw something of our flora, and zoologists had a successful dredging expedition, while the men of science as a body seemed wholly unable to resist the temptation of the excursions to the Jenolan Caves and the Blue Mountains. These proved so popular that they had to be duplicated.

The British Association has shown its appreciation of the Australian attitude to the meeting in a very practical form. Thanks to the large membership, the sum available for scientific grants is much greater than usual. A large part of this money has been allotted to the Local Committees, which have been appointed, in almost all the sections, to superintend Australian investigations. It is particularly gratifying to Australians that the Mawson Expedition has received special recognition, and that a grant has been given in aid of the production of the charts of Antarctic sea-depths, founded upon the observations of its members.

The good work done by members of the Association has not been confined to the official meetings. On the evening of their arrival, the astronomers met the local branch of the Astronomical Association; and the Astronomer-Royal and Prof. Turner gave up Sunday to visit in his home, some forty miles from Sydney, Mr. Tebbutt, the well-known Australian astronomer, whose advanced years prevented his attendance at Sydney. On Friday evening, Prof. Gonner and other economists and sociologists met with the local students of these subjects. On Saturday evening, Prof. Perry and Prof. Turner attended a special meeting of the local branch of the Mathematical Association, and by their addresses did a notable service to the teachers of mathematics in the secondary schools. On Sunday, one of the largest halls in the city was packed with an audience eager to hear Sir Oliver Lodge. Finally, the President of the Association filled up the vacancy created by the abandonment of the conversazione, by delivering an address in the Lecture Room of the Geological Department, when he showed a number of slides illustrating the first half of his presidential address, given in Melbourne. Thus, from the beginning of the meeting until its close the personality of its President was felt and realised.

H. S. CARSLAW.

NOTES.

SIR J. J. THOMSON, O.M., F.R.S., will deliver his presidential address to the Physical Society of London at the first meeting of the society, on Friday, October 23. The subject of the address will be "Ionisation," and the meeting will be held at the Imperial College of Science, South Kensington.

THE opening meeting of the new session of the Institution of Electrical Engineers will be held on Thursday, October 29, when the president, Sir John Snell, will deliver his inaugural address. At this meeting a marble bust of Michael Faraday will be presented to the institution by Mr. Llewellyn Preece, on behalf of the family of the late Sir William Preece, past president.

IN connection with the London County Council's work of indicating the houses in London which have been the residences of distinguished individuals, tablets have recently been erected commemorating the residence of Benjamin Franklin, at 36 Craven Street, and of the brothers Adam, at 4 Adelphi Terrace.

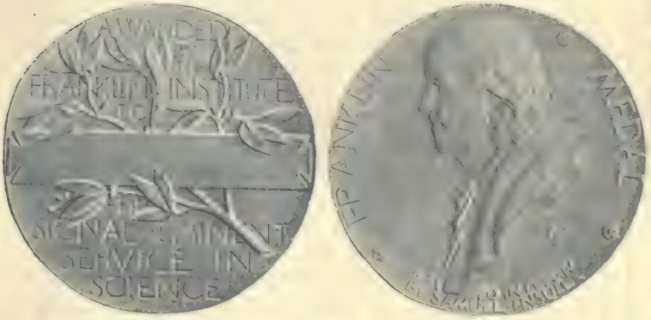
Engineering for October 9 has an article commenting on a paper by Mr. C. C. Humphris, of the Barrow Association of Engineers, and dealing with the development of the military small arm. Many charges of the use of unfair bullets have been made on both sides during the present campaign. The old Snider weapon made very bad wounds, but the penetrative power of the bullet sems to have been very small. With the Martini and the original Lee-Enfield bullet very clean wounds resulted. Mr. Humphris states that this is not the case with the new pointed bullet introduced by the Germans, which, unless it hits absolutely perpendicularly to the surface struck, is liable to turn round and proceed flat-long. He showed at the meeting of the association a block of oak fired at by Mark VI. and by Mark VII. ammunition, the latter having the new pointed bullet. The former made a clean hole 30 in. deep, while the latter turned round after entering the block, leaving a lacerated hole. According to Mr. Roosevelt, the tendency for the sharp-pointed bullet to turn in this way is only notable at short ranges.

THE *Engineer* for October 9 has a leading article on engineers and the sugar supply. It is estimated that to produce 1,500,000 tons of sugar would require some nine million tons of beet to be grown in this country. This would require, roughly, one million acres of land to be devoted to beet at one time. Beet should not be planted more often than once in three years—wheat and oats can be cultivated on the same land during the other two years. On the agricultural side, the idea of Great Britain being largely self-supporting as regards sugar is by no means chimerical. The machinery necessary for beet sugar factories can all be manufactured in this country—many of our makers produce it already. To meet the needs of manufacture, 110 factories are suggested, each dealing with 1000 tons of beet a day. Each factory would treat 80,000 tons of beet during its season of eighty days, and would deal with the produce of 8000 acres. The capital outlay on each factory would be about 120,000*l.*, and a profit of one-tenth penny per pound of sugar would give a return of about 10 per cent.—notwithstanding the fact that the factory would lie idle during the greater part of the year. The proposal seems to offer large commercial possibilities.

THE interest shown by the Americans in the exploitation of the resources of Peru is shown by the report of Mr. Osgood Hardy, reprinted from the Bulletin of the American Geographical Society, on the industrial prospects of South Central Peru, including the departments of Cuzco and Apurimac. The mineral resources of the district have been only imperfectly explored, and though some mines of silver and copper have been experimentally worked, the result has hitherto been inconsiderable. Above 12,000 ft. the potato is cultivated in a rude fashion, while at lower levels wheat, barley, and maize are grown. The district has recently been opened up by the railway to Cuzco, but the conditions of climate and labour supply are not promising, and the level of agriculture is so low that much demand for modern machinery is not to be anticipated. But so far as the resources of the native population go, some trade in cotton goods, tinned foods, cheap hardware, paints and oils, patent medicines, and toilet articles is being gradually developed.

DR. HIRAM BINGHAM, director of the Yale Peruvian Expedition, has issued two pamphlets reprinted from the bulletin of the American Geographical Society (vol. xlvi) and *Harper's Magazine* (August, 1914), describing his discovery of a mass of Inca ruins at Espiritu Pampa, Pampaconas Valley, lat. 12° 55′ long. 73° 24′. The district in which this city stood is at present occupied by a very primitive race, the Campa Indians, of whom some account with photographs is given. No other Inca ruins have hitherto been found so low down on the jungles of the Amazon valley. In the Relacion of Diego Rodriguez de Figueroa he describes meeting the Inca Titu Cusi Yupanqui in this neighbourhood, where possibly this was one of his royal cities. While the pottery and architecture are unquestionably of the Inca period it is curious to note that some Spanish roofing tiles were found. It is supposed that these may have been made experimentally by recent Peruvian occupants of the site, or possibly by some early Spanish missionaries who may have come here some three centuries ago.

THE Secretary of the Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts, in a letter from Philadelphia, informs us that a member of the institute, Mr. Samuel Insull, president of the Chicago Commonwealth Edison Company, has founded a medal for the institute, to be known as the Franklin medal. The medal is to be awarded from time to time to workers in physical science or technology, without regard to country, whose efforts, in the opinion of the board of management of the Franklin Institute, have done most to advance our knowledge of physical science or its application. Mr. Insull provided the sum of 1200*l.* for the execution of the scheme, and about 200*l.* has been applied for the purpose of paying for the design of the medal and the necessary dies and diploma plates. The medal is of gold, and has an intrinsic value of about 15*l.* Should the income derived from the fund be more than sufficient to provide such medals, the institute may award the surplus as premiums to accompany the medals. The medal has been designed by Dr. R. Tait McKenzie, of the University of Pennsylvania, and the accompanying illustration gives an idea of its general character.



Reverse. Obverse.

The Franklin Medal. Two-thirds natural size.

THE *Museum Journal* (vol. v., No. 2) describes an interesting collection of objects of Buddhist and Indian art, formed at Darjeeling, during a long residence, by Mr. A. Scott, which has been recently acquired by the Philadelphia Museum. Mr. Scott established close relations with the Tibetan Lamas, and the symbolism of the objects collected by him have been interpreted by Lama Dousand Up, of Darjeeling. Many of them are of Indian origin and display considerable artistic skill. The most valuable specimen is an ivory tablet representing the chief episodes in the life of Buddha. This is believed to be Assamese work of the fifth or sixth centuries A.D., and represents an early type of Buddhist iconography. Even more remarkable is, so far as can at present be ascertained, the only crystal statuette of Buddha known to collectors, that at Kandy, in Ceylon, being of Chinese manufacture, and comparatively modern. The collection also includes fine images of Dolma or Tara, the tutelary Tibetan goddess, of the eleven-headed Avalokitesvara, and of the Diamond Sow goddess, with some lamps and other examples of modern Nipalese art. The collection, while far from rivalling those of the British and India Museums, is of some importance, and its acquisition illustrates the interest in Indian art now shown in America.

THE chief items in the October number of *British Birds* are a report, by Mr. M. Vaughan, on last year's inquiry into the relative numbers of summer migrants to this country, and notes, by the editor, on the recapture of marked birds.

THE effects of the war are being so severely felt by the Selborne Society that in the October number of the *Selborne Magazine* an appeal is issued by the council urging all members to endeavour to increase the membership roll and to promote the interest of the society by such other means as lie in their power.

WE have to acknowledge the receipt of an article by Mr. R. R. Parker, from vol. xxv. of the Proc. Boston Nat. Hist. Soc., on the New England flies of the family Sarcophagidæ, and of a second, by Mr. T. Southwell, from vol. x. of the Journ. and Proc. Asiat. Soc. Bengal, on the tape-worms of India and Ceylon.

IT appears from the autumn number of *Bird Notes and News* that the nesting-boxes supplied to its constituents by the Royal Society for the Protection of Birds have hitherto been made in Germany; the industry is now, perforce, to be transferred to this country. The bird-sanctuary at Brean Down is reported to have been very successful during the past breeding-season; and it is also mentioned that perches and rests for birds have been fitted by Trinity House workmen, under the auspices of the society, to the South Bishop Lighthouse, Pembrokeshire.

PART ii. of vol. x. of Annals of the South African Museum is almost exclusively interesting to specialists, the contents including two papers by Mr. K. H. Barnard on the crustacean fauna of South Africa, with descriptions of many new species, and one by Miss G. Ricardo on the South African gadflies of the family Tabanidæ, also with diagnoses of new forms. Of somewhat wider interest is an account, by Mr. A. Raffray, of a strange-looking beetle taken in a termite-nest at Kimberley, and regarded as representing a new genus and species—*Gasterotropis poweri*—although closely related to the Indian Aphanetrix.

As announced in the *Morning Post* of October 8, the Natural History Museum has received the carcase of a female Sowerby's beaked whaled (*Mesoplodon bidens*), recently stranded at Rosslare, Ireland. Described by Sowerby in 1804, on the evidence of an individual washed ashore in Elgin four years previously, this cetacean is rarely met with, either in British or foreign waters, the present example being, it is stated, only the twelfth recorded from the coasts of the British Islands. It has been carefully dissected by Mr. W. P. Pycraft, who, we understand, has made some interesting observations with regard to the arrangement and relative proportions of certain of the visceral organs.

In the fourth part of vol. iv. of the Annals of the Transvaal Museum, Dr. E. C. N. van Hoepen continues his articles on the fossil reptiles of the Karroo beds, dealing in this instance with the lower jaw of the dicynodont Lystrosaurus (Ptychognathus). After describing the various elements which go to form this compound bone, the author refers to a paper by Mr. D. M. S. Watson, in the *Ann. Mag. Nat. Hist.* for December, 1912, in which he noticed that some of the features there described as distinctive of the lower jaw of Dicynodon do not accord with his own interpretation of the structure of that of Lystrosaurus. A re-examination of the lower jaws of both genera served to confirm Dr. van Hoepen's original diagnosis.

According to a communication from Messrs. G. H. Carpenter and T. R. Hewitt, in the October number of the *Irish Naturalist*, the vexed question as to the mode in which the maggots of warble-flies first effect entrance into the bodies of cattle has been finally settled. Hatched in many instances on the feet of their hosts, the minute maggots normally bore through the skin to the subjacent tissues, whence they eventually make their way to the back, where they encyst themselves in the well-known "warbles." Whether the second-stage maggots frequently observed in the gullets of cattle are merely enjoying a halt on their long subcutaneous journey from the limbs to the back, or whether they enter the mouth from outside, requires further investigation.

Reproductions of five beautiful autochrome photographs of the marvellous scenery—both as regards form and colour—of the Grand Canyon, Colorado, constitute an attractive and striking feature of the second (July) number of the Brooklyn Museum Quarterly. The letterpress includes a picturesque narrative, by Mr. R. C. Murphy, of a collecting cruise from Fernando Noronha to South Georgia, undertaken in 1912 on behalf of the museum. Lying as it does only 3½° south of the equator, and being cooled by a constant trade-wind, Fernando Noronha might be made one of the most productive islands in the world, instead of remaining the desolate convict-station of Brazil. In the Antarctic the party was chiefly occupied in observing whales, sea-elephants, and penguins and other birds, as well as in collecting such of the latter as were required for the museum. "On the South Georgia banks," writes the author, "the abundance of whales is nothing short of astounding, but as during our visit I sometimes saw eleven steamers hunting almost within hail of each other, and as twice that number often came into the ports with from two to ten whales apiece, the various species can scarcely hold their own many seasons longer."

The annual report of the Marine Biological Association of the West of Scotland for 1913 indicates that a considerable amount of advanced research work was done at the Millport Station during the year. Summaries of the results are given in the report of the superintendent, Mr. R. Elmhirst, and in abstracts of papers read at meetings of the association held in Glasgow. The most striking portion of the report is a lecture by Prof. E. W. MacBride, on some problems of marine biology, which gives a useful summary of the lecturer's recent researches on hybridisation of echinoderms.

The report of the Cullercoats Marine Laboratory for the year ending June, 1914, is characterised rather by the number of subjects studied and the extent of the ground covered than by the importance of the new information furnished on any particular subject. Prof. Meek's papers on trawling experiments and on migrations of plaice and dab deal with small numbers and do not furnish anything strikingly new. The discussion on the probable origin of the migrations is interesting and suggestive, but from the nature of the case it is entirely speculative. Work on races of herrings, commenced in 1912, has been continued. The number of fish measured is larger than in previous years, and this research is probably the most important contribution to fishery science in the report. Other papers deal with crabs and lobsters, mussel and lobster culture, and the pollution of the river Tyne. There are also two faunistic papers on hydrozoa by J. H. Robson.

The meteorological chart of the North Atlantic Ocean for October, published by the Meteorological Office, states that steamers crossing that ocean are not likely to experience much, if any, delay from fog. With the exception of a few small areas of mist, neither fog nor mist is probable south of the parallel of 40° N. and west of longitude 20° W. It is not unlikely, however, that thick weather may be experienced on parts of the coast of Africa; this is principally due to red dust blown seaward from the Sahara and to mist from marked changes of temperature of air and sea. December to April are said to be the months of maximum frequency of red dust.

We have received from Mr. J. Baxendell, the energetic meteorologist to the Southport Corporation, the report of the results of observations for the year 1913 at the exceptionally well equipped station at that place. Returns are regularly supplied to the Meteorological Office, together with telegraphic notice of all gales. In the course of the year the hourly statistics of the duration of winds from different directions (partially published in 1912) have been materially extended. These, when discussed, as promised, will throw much light on the climate of Southport. With reference to the latter, Mr. Baxendell remarks that, owing to the sea breezes, all the summer months are cool by day; generally speaking, there is more sunshine in the afternoon than in the morning. July is the best month of the year for outdoor life; May and June, and even September, are more settled than August. The report includes, as usual, a very handy table of comparative climatological statistics at health resorts and large towns, compiled from Meteorological Office data.

In the Bulletin of the Calcutta Mathematical Society, vol. ii., part 1 (Calcutta University Press, 1914), a paper is published by Mr. Jibon M. Bose, on the equations of motion of a plane kite, with special reference to its equilibrium, small oscillations, and conditions of stability. The paper thus constitutes a solution of Problem 16 of Bryan's "Stability in Aviation" (p. 180). In the case in which the kite is a plane lamina without keels, the author, as might be expected, obtains cubic equations for the longitudinal and lateral stability. This result is in accordance with the corresponding results for an aeroplane in which certain roots of the biquadratics vanish unless the aeroplane is provided with auxiliary surfaces.

The *Morning Post's* "own correspondent" in Rome announces that Prof. Argentieri, of Aquila (there is no university in Aquila, and we do not find Prof. Argentieri's name in "Minerva"), has invented a "pocket" system of radio-telegraphy, in which apparatus costing twelve shillings is capable of intercepting messages from the Eiffel Tower, a distance of 730 miles, that the German Government has offered him a large sum of money for the system, and that he has patriotically refused it, preferring to place his invention at the service of his own Government. It is true that the aerial for receiving messages of high power need not necessarily be of great length, that a great deal of wire can be coiled up in the pocket and erected on light portable posts to a considerable height, and it is also true that the remaining apparatus, for receiving only, may be of small bulk, but one can well be sceptical as to the authenticity of such a statement as the above. Perhaps the time will come when a man may slip a telephone receiver over his head, put up an aluminium-framed umbrella, stand with his feet in a puddle, and, using a battery, induction coil, and a sending key disposed in various pockets, and a detector in his hat, communicate freely with friends a few hundred miles away. But we have not reached this point yet, and, at present prices, the aluminium umbrella alone would probably cost twelve shillings. We are willing to give Mr. Argentieri the full credit his invention deserves so soon as he has found an opportunity to explain its details or to demonstrate its capabilities, but, in the meantime, we cannot take seriously the description given in our contemporary.

The following forthcoming books are additional to those announced in our issue of last week:—In *Anthropology and Archaeology*: The Literature of the Ancient Egyptians, Dr. E. A. Wallis Budge; A History of the Egyptian People, Dr. E. A. Wallis Budge (J. M. Dent and Sons, Ltd.); Ægean Archæology, H. R. Hall (The Medici Society, Ltd.); A Hausa Phrase Book, with Medical and Scientific Vocabularies, A. C. Parsons; Contributions to the Ethnology of the Salish Tribes, J. A. Teit; Coos Texts, L. J. Frachtenberg (Oxford University Press). In *Geography and Travel*: Life and Death in the Antarctic, Sir D. Mawson, two vols., illustrated (W. Heinemann); Indo-China and its Primitive People, Capt. H. Baudesson, illustrated; The Roman Colonies of North Africa, and their Ruined Cities, R. Sturzenbecker, illustrated (Hutchinson and Co.); Geography of Eastern Asia, D. Paton (Oxford University Press); On the Trail of the Opium Poppy, Sir A. Hosie, two vols., illustrated (G. Philip and Son, Ltd.); Travels in the Middle East, Lieut. T. C. Fowle, illustrated; The Voyages of Capt. Scott, retold by C. Turley, illustrated (Smith, Elder and Co.). In *Mathematics and Physical Science*: Electric Waves, Prof. G. W. Pierce; The Emission of Electricity from Hot Bodies, Prof. O. W. Richardson; Colloidal Solutions, Prof. E. F. Burton; Atmospheric Ionization, Prof. J. C. McLennan (each in the series of Monographs on Physics), (Longmans and Co.); Elementary Principles in Statistical Mechanics, Prof. J. Willard Gibbs (Oxford University Press). In *Medical Science*: The Evolution of Modern Medicine, Sir W. Osler (Oxford University Press). In *Metallurgy*: Zinc, Dr. J. S. G. Primrose; Aluminium, Dr. R. Seligmann; Metallurgy of Strain, S. C. W. Humfrey; Brass, G. D. Bengough; Refractory Metals, W. C. Hancock (Constable and Co., Ltd.). In *Technology*: Electrical Installation Manuals on Conductors, House Wiring, etc.; Lamps, Switches, Fittings, Transformers; Bells, Telephones, etc.; Testing and Localizing Faults (Constable and Co., Ltd.); Architectural Acoustics, W. C. Sabine (Oxford University Press).

A new and cheaper edition of the late Dr. Alfred Russel Wallace's book, "The World of Life: a Manifestation of Creative Power, Directive Mind, and Ultimate Purpose," has been published by Messrs. Chapman and Hall, Ltd. In its original form the work was reviewed at length in our issue for June 8, 1911 (vol. lxxxvi., p. 481), and it will be sufficient here to say that it can now be obtained at the price of 6*s*. net.

OUR ASTRONOMICAL COLUMN.

Comet 1913*f* (Delavan).—M. P. Puiseux communicates to the *Comptes rendus* for September 28 (vol. clix., No. 13) an account of photographs of Delavan's comet (1913*f*) which have been obtained at the Paris Observatory with the Henry-Gautier equatorial on September 5 and 6. The plates are impressed with a réseau, and each shows at least six stars which figure in the catalogues of the Astronomische Gesellschaft, executed at Bonn and Cambridge, together with a large number of fainter stars. Thus the necessary data are available for the determination of two accurate positions of this object. The comet on these dates was a little fainter than a 3·3 magnitude star. M. Coggia, in the same number of the *Comptes rendus*, gives five observations of positions of this comet made between September 14 and 18. On these dates the comet presented a round nucleus of about magnitude 5 with a tail of about 1° in length.

A Central Bureau for Transmission of Astronomical News.—At the present time astronomers have no available organisation by which the news of important astronomical discoveries can be quickly distributed to the leading observatories of the world, nor is there a bureau with which anyone making an important discovery can immediately communicate with the knowledge that the news will at once be circulated world wide. This condition of affairs is due to the fact that the recognised Central Bureau is at Kiel, in Germany, and that the state of war prevents the circulation of any such news. No steps, so far as is known, are being taken to remedy this defect, and for this reason the attention of astronomers should be directed to the necessity of some definite action to correct this unsatisfactory state of affairs. There is little doubt that if the Royal Astronomical Society of Great Britain would undertake, even if only as a temporary measure, the task of receiving and disseminating astronomical information, this act would meet with the approval of astronomers all the world over. Perhaps the council of this society might be persuaded to consider this suggestion at their next meeting. In the meantime a useful purpose might be served if astronomers at home and abroad stated their views on the subject so that proper steps can be taken for the formation of a permanent astronomical bureau.

The Sidereal Centre of the Universe.—That brilliant star, Canopus, or α Argus, more familiar to those who live in southern latitudes, has been brought into prominence by the interesting communication made to *Knowledge* in the August issue. In discussing the positions in space of the helium, or B stars, which stars, whether faint or bright, are situated at vast distances from us, and are free from preferential motion or star streaming, Mr. O. R. Walkey is led to conclude that peculiar interest becomes attached to the star Canopus in that it occupies the approximate position derived for the centre of the stellar system. In the article in question he gives his reasons for concluding that the distance of this star is of the same order as that indicated for this helium star centre, that Canopus appears to be stationary with reference to these helium stars, that its luminosity and mass are in character with their suggested significance, that the relative motions of the faint stars in the vicinity of Canopus indicate an orbital motion confirming the independently derived mass, and finally that the component of the solar motion tangential to Canopus indicates the existence of such a mass at the given distance. While the author makes it clearly understood that the views set forth do not prove the central position of Canopus, yet he shows that the evidence brought forward from many points of view all point consistently in the same direction.

THE ITALIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE report of the seventh meeting of the Italian Society for the Advancement of Science, which was held in Siena in September, 1913, has been recently issued; it contains a full account of the meeting and of the papers read before the society. The report contains pp. lviii + 1091, and is a striking testimony to the rapid development of the society, which is now only in its seventh year of existence, the first meeting having been held at Parma in 1907. The work of the society is divided broadly into three classes, Class A being devoted to the physical and mathematical sciences, with five sections—astronomy and mathematics; physics and applied mechanics, including electrotechnics; chemistry; mineralogy and geology; and geography. Class B includes the biological sciences, and is divided into four sections, dealing respectively with anatomy and zoology; botany and agriculture; physiology; pathology and hygiene. Class C comprises the moral sciences, and is subdivided into eight sections—archæology and the history of art; the history of science; philology; economic and social sciences; legal sciences; philosophy; history and the history of religion.

The meeting was opened by Prof. Pietro Rossi, the rector of the University of Siena, the inaugural address being delivered by Prof. Antonio Garbasso, who chose as his subject "The Principles of Mechanics." General addresses were delivered by Prof. G. Pighini on nervous energy and the chemico-physics of protoplasm; by Colonel E. Caviglia on the work executed in Libya by the Institute of Military Geography; and by Prof. A. Sclavo on the laws of hygiene. Prof. E. Manasse gave an address on the mineral resources of the Sienese territory, Prof. Valenti on the conditions and problems of the colony of Erythrea, Prof. F. Ferrara on the Mahometan law in the districts of Tripoli and Cyrene, and Prof. Rossi on the character of Sienese art from medieval times to the renaissance.

Among the sectional addresses the following may be mentioned:—Prof. S. Lussana on the thermodynamics of gases and liquids in reference to practical applications; Prof. A. Pochettino, fluorescence and phosphorescence; Prof. C. Acqua, the liberation of energy in the respiratory processes of plants; Prof. R. Pirotta, the alternation of generations in lower plants; Dr. M. Almagià, our present knowledge of malignant tumours; Prof. E. Centanni, new studies of the "formative stimulus"; Prof. E. Ficalbi, on F. C. Marmocchi, a pre-Darwinian evolutionist, and his views; Prof. C. Ulpiani, applications of thermodynamics to biology; Prof. D. Barduzzi, the Galilean method in the medical sciences; Prof. B. Varisco, science and the theory of science; Prof. R. Pettazzoni, the origin of the idea of God; Prof. C. Parvopassu; recent progress in the science and technics of construction; Prof. P. Gucci, the ideas of Galileo on the divisibility of matter; Prof. E. Carusi, the relation between Roman law and Mahometan law; Prof. C. De Stefani, recent American theories in geology.

Of the numerous papers read before the different sections and printed in full in the report it is possible here only to give the titles of a few which possess some general interest. In Class A, Prof. T. Levi Civita read a paper on the Torricellian theorem; Prof. G. Testa on a modification of Atwood's machine; Prof. M. Panetti on testing light motors at the aeronautical laboratory of the Turin Polytechnic; Captain G. Costanzi on aerodynamic and hydrodynamic tests in connection with aeroplanes; G. Ivaldi on the true kinetic theory of gases. Prof. M. Berti and Dr. S. Ciocchetti, a new type of phototropic substances; Profs. L. Francesconi and N. Granata, the constitution of the cyclic ketones of oil of santolin.

In Class B, Prof. R. Perotti, a general scheme for the utilisation of town sewage; Prof. R. Bargagli-Petrucci, the biological origin of the soil of Siena; Prof. G. Pollacci, on the bioreaction of tellurium and its application to the study of physiology and vegetable pathology; Prof. B. Bocci, the cerebral nerve-cell and its specific work; Prof. L. Sabbattani, colloidal carbon; Prof. A. Constantino, experiments on amino-acids; Prof. F. Nassetti, comparative study of plant and animal tumours; Prof. V. Sebastiani, influence of diet on tumours.

In Class C (moral sciences) only a few of the numerous papers read can be referred to. Prof. E. Fornasari di Verce dealt with the relation between the birth- and death-rate of Italy; Prof. F. Filomuse-Guelfi, with modern idealism and the philosophy of law; Prof. A. Fracassini, the beginnings of the struggle of the Roman Empire against Christianity.

The meeting of the society lasted for five days, from Monday, September 22, to Friday, September 26, 1913.

RAINFALL OBSERVATIONS.

A USEFUL discussion by Prof. A. G. McAdie on the rainfall of California forms No. 4, vol. i., of the *University of California Publications in Geography*. The data used are chiefly the records of the U.S. Weather Bureau and extend for some localities over a period of sixty-three years. Among the chief factors controlling the rainfall of the State may be mentioned its diversified topography, the prevalent westerly winds from the Pacific Ocean, and the relatively cold California current. For convenience of discussion, the State has been divided into five sections, bearing some relation to the principal watersheds, and for each division are given the notable climatic features and a general statement of the distribution of rainfall and of its variation with altitude, while more detailed information is shown by tables and plates. Summer in California is practically rainless, but for other seasons certain portions of the State are considered by the author as lying within the zone of maximum intensity of rainfall in the United States. The greatest annual amount during the past ten years was 153½ in. in Del Norte County, and amounts exceeding 100 in. have occurred at many places. Apparently the heaviest monthly fall in the United States (71½ in.) occurred at Helen Mine (Cal.) in January, 1909. The rainfall of San Francisco is dealt with in considerable detail; the annual mean (sixty-four years) was 22·6 in., maximum yearly fall 38·8 in., minimum 9·3 in. The longest drought was 175 days in the summer half year of 1903.

As a supplement to "Rainfall Observations" for the year 1912, the Norwegian Meteorological Institute has published a volume (with charts) giving mean and extreme values of rainfall since its establishment towards the end of 1866. During the first few years of its existence the stations were few, but in 1912 the number reached 492. The tables include *inter alia* five-yearly means for 1876–1910, normal monthly and yearly values and extremes and days of rain and snow for the total number of years available, with summaries of days with amounts varying from 0·1 to 1·0 mm. The charts include normal yearly values (isohyets) for 1876–1910. These show very clearly the effect of storms and topography upon the rainfall. The curves along the south-west and west shores, which lie in the direct track of cyclonic depressions, show that the normal amounts range from 1000–1600 mm., while in districts not far inland amounts of 2000–3000 mm. are not unusual. In the more northerly and inland parts the values range from 600–1000 mm., and still less, especially in the extreme north-eastern districts. The work is a very valuable contribution to the climatology of an extensive tract, reaching beyond the 71st parallel of latitude.

The report of the director of the Egyptian Meteorological Service (Mr. J. I. Craig) on the rains of the Nile Basin and the Nile flood of 1912 follows the general lines of its predecessors. During the year rainfall was measured at 112 stations, and that recorded at 143 other places was taken into account. On the whole of the year rains were in excess on the eastern slopes of East Africa and of the Red Sea, but normal to weak everywhere else. The differences from the mean, and the average deviations by districts, are shown by tables, as usual. Mr. Craig states that the low stage of the river in 1912 was very poor, and that lower gauges were touched on the Bahr el Jebel than ever before. The flood was late; it was not until the beginning of August that the gauge at Wadi Halfa rose above normal, after which it continued so until August 21. A chapter is devoted to the extension of the usual equation for the flow of water in open channels, to include all the factors which affect the discharge, and the theory is applied to calculate the losses on the White Nile in the beginning of the year in question. The report concludes with the readings of the chief river gauges in Egypt and the Sudan.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SUB-SECTION A.

COSMICAL PHYSICS.

OPENING ADDRESS BY PROF. E. W. BROWN, F.R.S., CHAIRMAN OF THE SUB-SECTION.

To one who has spent many years over the solution of a problem which is somewhat isolated from the more general questions of his subject, it is a satisfaction to have this opportunity for presenting the problem as a whole instead of in the piecemeal fashion which is necessary when there are many separate features to be worked out. In doing so, I shall try to avoid the more technical details of my subject as well as the temptation to enter into closely reasoned arguments, confining myself mainly to the results which have been obtained and to the conclusions which may be drawn from them.

In setting forth the present status of the problem, another side of it gives one a sense of pleasure. When a comparison between the work of the lunar theorist and that of the observer has to be made, it is necessary to take into consideration the facts and results obtained by astronomers for purposes not directly connected with the moon: the motions of the earth and planets, the position of the observer, the accuracy of star catalogues, the errors of the instruments used for the measurement of the places of celestial objects, the personality of the observers—all these have to be considered; in fact, almost every one of the departments of the astronomy of position must be drawn upon to furnish necessary data. The time has now arrived when it may perhaps be possible to repay in some measure the debt thus contracted by furnishing to the astronomer, and perhaps also the student of geodesy, and, if I may coin a word, of selenodesy, some results which can be deduced more accurately from a study of the moon's motion than in any other way. A long-continued exploration with few companions which ultimately leads to territories where other workers have already blazed paths gives the impression of having emerged from the thick jungle into open country. The explorer can once more join forces with his brother astronomers. He can judge his own results more justly and have them judged by others. If, then, an excuse be needed for overstepping the limits which seem, by silent consent, to have been imposed on those who devote themselves to lunar problems, it consists in a desire to show that these limits are not necessary and that a study of the motion of the moon can be of value and can contribute its share to the common funds of astronomy.

The history of the motion of the moon has been for more than two centuries a struggle between the theorists and the observers. Ever since the publication of the "Principia" and the enunciation of the law of gravitation by Isaac Newton, a constant effort has been maintained to prove that the moon, like the other bodies of the solar system, obeyed this law to its farthest consequences. While the theory was being advanced, the observers were continually improving their instruments and their methods of observing, with the additional advantage that their efforts had a cumulative effect; the longer the time covered by their observations, the more exact was the knowledge obtained. The theorist lacked the latter advantage; if he started anew he could only use the better instruments for analysis provided by the mathematician. He was always trying to forge a plate of armour which the observer with a gun the power of which was increasing with the time could not penetrate. In the struggle the victory rarely failed to rest with the observer. Within the last decade we theorists have made another attempt to forge a new plate out of the old materials; whether we have substantially gained the victory must rest partly on the evidence I have to place before you to-day and partly on what the observer can produce in the near future.

There are three well-defined periods in the history of the subject so far as a complete development of the moon's motion is concerned. From the publication of the "Principia" in 1687, when Newton laid down the broad outlines, until the middle of the eighteenth century, but little progress was made. It seems to have required more than half a century for analysis by symbols to advance sufficiently far for extensive applications to the problems of celestial mechanics. Clairaut and d'Alembert both succeeded in rescuing the problem from the geometrical form into which Newton had cast it and in reducing it to analysis by the methods of the calculus. They were followed by Leonard Euler, who in my opinion is the greatest of all the successors of Isaac Newton as a lunar theorist. He initiated practically every method which has been used since his time, and his criticisms show that he had a good insight into their relative advantages. A long roll of names follows in this period. It was closed by the publication of the theories of Delaunay and Hansen and the tables of the latter, shortly after the middle of the nineteenth century. From then to the end of the century the published memoirs deal with special parts of the theory or with its more general aspects, but no complete development appeared which could supersede the results of Hansen.

My own theory, which was completed a few years ago, is rather the fulfilment to the utmost of the ideas of others than a new mode of finding the moon's motion. Its object was severely practical—to find in the most accurate way and by the shortest path the complete effect of the law of gravitation applied to the moon. It is a development of Hill's classic memoir of 1877. Hill in his turn was indebted to some extent to Euler. His indebtedness would have been greater had he been aware of a little-known paper of the latter, "Sur la Variation de la Lune," in which the orbit, now called the variation orbit, is obtained, and its advantages set forth in the words: "Quelque chimérique cette question j'ose assurer que, si l'on réussissoit à en trouver une solution parfaite on ne trouveroit presque plus de difficulté pour déterminer le vraî mouvement de la Lune réelle. Cette question est donc de la dernière importance et il sera toujours bon d'en approfondir toutes les difficultés, avant qu'on en puisse espérer une solution complète."

In the final results of my work the development aims to include the gravitational action of every particle of matter which can have a sensible effect on the moon's motion, so that any differences which appear between theory and observation may not be set down to want of accuracy in the completeness with which the theory is carried out. Every known force capable of calculation is included.

So much for the theory. Gravitation, however, is only a law of force; we need the initial position, speed, and direction of motion. To get this with sufficient accuracy no single set of observations will serve; the new theory must be compared with as great a number of these as possible. To do this directly from the theory is far too long a task, and, moreover, it is not necessary. In the past every observation has been compared with the place shown in the "Nautical Almanac," and the small differences between them have been recorded from day to day. By taking many of these differences and reducing them so as to correspond with differences at one date, the position of the moon at that date can be found with far greater accuracy than could be obtained through any one observation. At the Greenwich Observatory the moon has been observed and recorded regularly since 1750. With some 120 observations a year, there are about 20,000 available for comparison, quite apart from shorter series at other observatories. Unfortunately these observations are compared with incorrect theories, and, in the early days, the observers were not able to find out, with the accuracy required to-day, the errors of their instruments or the places of the stars with which the moon was compared. But we have means of correcting the observations, so that they can be freed from many of the errors present in the results which were published at the time the observations were made. We can also correct the older theories. They can be compared with the new theory and the differences calculated; these differences need not even be applied to the separate observations, but only to the observations combined into properly chosen groups. Thus the labour involved in making use of the earlier observations is much less than might appear at first sight.

For the past eighteen months I have been engaged in this work of finding the differences between the old theories and my own, as well as in correcting those observations which were made at times before the resources of the astronomer had reached their present stage of perfection. I have not dealt with the observations from the start; other workers, notably Airy, in the last century, and Cowell in this, have done the greater part of the labour. My share was mainly to carry theirs a stage further by adopting the latest theory and the best modern practice for the reduction of the observations. In this way a much closer agreement between theory and observation has been obtained, and the initial position and velocity of the moon at a given date are now known with an accuracy comparable with that of the theory. I shall shortly return to this problem and exhibit this degree of accuracy by means of some diagrams which will be thrown on the screen.

I have spoken of the determination of these initial values as if it constituted a problem separate from the theory. Theoretically it is so, but practically the two must go together. The increase in accuracy of the theory has gone on successively with increase in accuracy of the determination of these constants. We do not find, with a new theory, the new constants from the start, but corrections to the previously adopted values of these constants. In fact, all the problems of which I am talking are so much interrelated that it is only justifiable to separate them for the purposes of exposition.

Let us suppose that the theory and these constants have been found in numerical form, so that the position of the moon is shown by means of expressions which contain nothing unknown but the time. To find the moon's place at any date we have then only to insert that date and to perform the necessary numerical calculations. This is not done directly, on account of the labour involved. What are known as "tables of the Moon's Motion" are formed. These tables constitute an intermediate step between the theory and the positions of the moon which are printed in the "Nautical Almanac." Their sole use and necessity is the abbreviation of the work of calculation required to predict the moon's place from the theoretical values which have been found. For this reason, the problem of producing efficient tables is not properly scientific; it is mainly economic. Nevertheless, I have found it as interesting and absorbing as any problem which involves masses of calculation is to those who are naturally fond of dealing with arithmetical work. My chief assistant, Mr. H. B. Hedrick, has employed his valuable experience in helping me to devise new ways of arranging the tables and making them simple for use.

A table is mainly a device by which calculations which are continually recurring are performed once for all time, so that those who need to make such calculations can read off the results from the table. In the case of the moon, the tables go in pairs. Each term in the moon's motion depends on an angle, and this angle depends on the date. One table gives the value of the angle at any date (a very little calculation enables the computer to find this), and the second table gives the value of the term for that angle. As the same angles are continually recurring, the second table will serve for all time.

We can, however, do better than construct one table for each term. The same angle can be made to serve for several terms, and consequently one table may be constructed so as include all of them. In other words, instead of looking out five numbers for five separate terms, the computer looks out one number which gives him the sum of the five terms. The more terms we can put into a single table the less work for the astronomer who wants the place of the moon, and therefore the more efficient the tables. A still better device is a single table which depends on two angles, known as a double-entry table; many more terms can usually be included in this than in a single-entry table. The double interpolation on each such table is avoided by having one angle the same for many double-entry tables and interpolating for that angle on the sum of the numbers extracted from the tables.

The problem of fitting the terms into the smallest number of tables is a problem in combinations—something like a mixture of a game at chess and a picture-puzzle, but unlike the latter in the fact that the intention is to produce ease and simplicity instead of difficulty. This work of arrangement is now completed, and, in fact, about five-sixths of the calculations necessary to form the tables are done; more than one-third of the copy is ready for the printer, but, owing to the large mass of the matter, it will take from two to three years to put it through the press. The cost of performing the calculations and printing the work has been met from a fund specially set aside for the purpose by Yale University.

A few statistics will perhaps give an idea of our work. Hansen has 300 terms in his three coordinates, and these are so grouped that about a hundred tables are used in finding a complete place of the moon. We have included more than 1000 terms in about 120 tables, so that there are on the average about eight terms per table. (In one of our tables we have been able to include no fewer than forty terms.) Each table is made as extensive as possible in order that the interpolations—the bane of all such calculations—shall be easy. The great majority of them involve multiplications by numbers less than 100. There are fewer than ten tables which will involve multiplications by numbers between 100 and 1000, and none greater than the latter number. The computer who is set to work to find the longitude, latitude, and parallax of the moon will not need a table of logarithms from the beginning to the end of his work. The reason for this is that all multiplications by three figures or less can be done by Crelle's well-known tables or by a computing machine. But Mr. Hedrick has devised a table for interpolation to three places which is more rapid and easy than either of these aids. It is, of course, of use generally for all such calculations, and arrangements are now being made for the preparation and publication of his tables. The actual work of finding the place of the moon from the new lunar tables will, I believe, not take more time—perhaps less—than from Hansen's tables, so soon as the computer has made himself familiar with them. Fortunately for him, it is not necessary to understand the details of their construction; he need only know the rules for using them.

I am now going to show by means of some diagrams the deviations of the moon from its theoretical orbit, in which, of course, errors of observation are included. The first two slides exhibit the average deviation of the moon from its computed place for the past century and a half in longitude.[1] The averages are taken over periods of 414 days and each point of the continuous line shows one such average. The dots are the results obtained by Newcomb from occultations; the averages for the first century are taken over periods of several years, and in the last sixty years over every year. In both cases the same theory and the same values of the constants have been used. Only one empirical term has been taken out—the long-period fluctuation found by Newcomb having a period of 270 years and a coefficient of 13″. I shall show the deviations with this term included, in a moment.

The first point to which attention should be directed is the agreement of the results deduced from the Greenwich meridian observations and those deduced from occultations gathered from observatories all over the world. There can be no doubt that the fluctuations are real and not due to errors of observation. A considerable difference appears about 1820, for which I have not been able to account, but I have reasons for thinking that the difference is mainly due to errors in the occultations rather than in the meridian values. In the last sixty years the differences become comparatively small, and the character of the deviation of the moon from its theoretical orbit is well marked. This deviation is obviously of a periodic character, but attempts to analyse it into one or two periodic terms have not met with success; the number of terms required for the purpose is too great to allow one to feel that they have have a real existence, and that they would combine to represent the motion in the future. The straight line character of the deviations is a rather marked peculiarity of the curves.

The actual deviations on a smaller scale are shown in the next slide; the great empirical term has here been restored and is shown by a broken line. The continuous line represents the Greenwich meridian observations; the dots are Newcomb's results for the occultations before 1750, the date at which the meridian observations begin. With a very slight amount of smoothing, especially since 1850, this diagram may be considered to show the actual deviations of the moon from its theoretical orbit.

The next slide shows the average values of the eccentricity and of the position of the perigee.[2] The deviations are those from the values which I have obtained. It is obvious at once that there is little or nothing systematic about them; they may be put down almost entirely to errors of observation. The diminishing magnitude of the deviations as time goes on is good evidence for this; the accuracy of the observations has steadily increased. The coefficient of the term on which the eccentricity depends is found with a probable error of 0·02″, and the portion from 1750 to 1850 gives a value for it which agrees with that deduced from the portion 1850 to 1901 within 0·01″. The eccentricity is the constant which is now known with the highest degree of accuracy of any of those in the moon's motion. For the perigee there was a difference from the theoretical motion which would have caused the horizontal average in the curve to be tilted up one end more than 2″ above that at the other end. I have taken this out, ascribing it to a wrong value for the earth's ellipticity; the point will be again referred to later. The actual value obtained from the observations themselves has been used in the diagram, so that the deviations shown are deviations from the observed value.

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[1] *Monthly Notices, R.A.S.*, vol. lxxiii., plate 22.

[2] Tables II. and III. of a paper on "The Perigee and Eccentricity of the Moon," *Monthly Notices, R.A.S.*, March, 1914.

The next slide shows the deviations of the mean inclination and the motion of the node, as well as of the mean latitude from the values deduced from the observations.[3] In these cases the observations only run from 1847 to 1901. It did not seem worth while to extend them back to 1750, for it is evident that the errors are mainly accidental, and the mean results agreed so closely with those obtained by Newcomb from occultations that little would have been gained by the use of the much less accurate observations made before 1847. The theoretical motion of the node differs from its observed value by a quantity which would have tilted up one end of the zero line about 0·5″ above the other; the hypothesis adopted in the case of perigee will account for the difference.

The mean latitude curve is interesting. It should represent the mean deviations of the moon's centre from the ecliptic; but it actually represents the deviations from a plane 0·5″ below the ecliptic. A similar deviation was found by Newcomb. Certain periodic terms have also been taken out. The explanation of these terms will be referred to directly.

The net result of this work is a determination of the constants of eccentricity, inclination, and of the positions of the perigee and node with practical certainty. The motions of the perigee and node here agree with their theoretical values when the new value of the earth's ellipticity is used. The only outstanding parts requiring explanation are the deviations in the mean longitude. If inquiry is made as to the degree of accuracy which the usual statement of the gravitation law involves, it may be said that the index which the inverse square law contains does not differ from 2 by a fraction greater than 1/400,000,000. This is deduced from the agreement between the observed and theoretical motions of the perigee when we attribute the mean of the differences found for this motion and for that of the node to a defective value of the ellipticity of the earth.

I have mentioned the mean deviation of the latitude of the moon from the ecliptic. There are also periodic terms with the mean longitude as argument occurring both in the latitude and the longitude. My explanation of these was anticipated by Prof. Bakhuysen by a few weeks. The term in longitude had been found from two series of Greenwich observations, one of twenty-eight and the other of twenty-one years, by van Steenwijk, and Prof. Bakhuysen, putting this with the deviations of the mean latitude found by Hansen and himself, attributed them to systematic irregularities of the moon's limbs.

What I have done is to find (1) the deviation of the mean latitude for sixty-four years; (2) a periodic term in latitude from observations covering fifty-five years; and (3) a periodic term in longitude from observations covering 150 years, the period being that of the mean longitude. Further, if to these be added Newcomb's deviations of the mean latitude derived (*a*) from immersions and (*b*) from emersions, we have a series of five separate determinations—separate because the occultations are derived from parts of the limb not wholly the same as those used in meridian observations. Now all these give a consistent shape to the moon's limb referred to its centre of mass. This shape agrees qualitatively with that which may be deduced from Franz's figure.

I throw on the screen two diagrammatic representations[4] of these irregularities obtained by Dr. F. Hayn from a long series of actual measures of the heights and depths of the lunar formations. The next slide shows the systematic character more clearly. It is from a paper by Franz.[5] It does not show the character of the heights and depths at the limb, but we may judge of these from the general character of the high and low areas of the portions which have been measured and which extend near to the limbs. I think there can be little doubt that this explanation of these small terms is correct, and if so it supplies a satisfactory cause for a number of puzzling inequalities.

The most interesting feature of this result is the general shape of the moon's limb relative to the centre of mass and its relation to the principle of isostasy. Here we see with some definiteness that the edge of the southern limb in general is further from the moon's centre of mass than the northern. Hence we must conclude that the density at least of the crust of the former is less than that of the latter, in accordance with the principle mentioned. The analogy to the figure of the earth with its marked land and sea hemispheres is perhaps worth pointing out, but the higher ground in the moon is mainly on the south of its equator, while that on the earth is north. Unfortunately we know nothing about the other face of the moon. Nevertheless it seems worth while to direct the attention of geologists to facts which may ultimately have some cosmogonic applications. The astronomical difficulties are immediate: different corrections for meridian observations in latitude, in longitude, on Mösting A, for occultations and for the photographic method, will be required.

I next turn to a question, the chief interest of which is geodetic rather than astronomical. I have mentioned that a certain value of the earth's ellipticity will make the observed motions of the perigee and node agree with their theoretical values. This value is 1/293·7 ± 0·3. Now Helmert's value obtained from gravity determinations is 1/298·3. The conference of "Nautical Almanac" directors in 1911 adopted 1/297. There is thus a considerable discrepancy. Other evidence, however, can be brought forward. Not long ago a series of simultaneous observations at the Cape and Greenwich Observatories was made in order to obtain a new value of the moon's parallax. After five years' work a hundred simultaneous pairs were obtained, the discussion of which gives evidence of their excellence. Mr. Crommelin, of the Greenwich Observatory, who undertook this discussion, determined the ellipticity of the earth by a comparison between the theoretical and observed values of the parallax.

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[3] "The Mean Latitudes of the Sun and Moon," *Monthly Notices, R.A.S.*, January, 1914: "The Determination of the Constants of the Node, the Inclination, the Earth's Ellipticity, and the Obliquity of the Ecliptic," *ibid.*, June, 1914.

[4] *Abh. der Math.-Phys. Kl. der Kön. Sächs. Ges. der Wiss.*, vols. xxix., xxx.

[5] *Königsberger Astr. Beob.*, Abth., 38

He found an ellipticity 1/294·4 ± 1·5 closely agreeing with that which I have obtained. Finally, Col. Clarke's value obtained from geodetic measures was 1/293·5. We have thus three quite different determinations ranging round 1/294 to set against a fourth determination of 1/298. The term in the latitude of the moon which has often been used for this purpose is of little value on account of the coefficient being also dependent on the value of the obliquity of the ecliptic; such evidence as it presents is rather in favour of the larger value. I omit Hill's value, obtained from gravity determinations, because it is obviously too large.

Here, then, is a definite issue. To satisfy the observations of the moon in at least three different parts, a value near 1/294 must be used; while the value most carefully found from gravity determinations is 1/298. So far as astronomy is concerned, the moon is the only body for which a correct value of this constant is important, and it would seem inadvisable to use a value which will cause a disagreement between theory and observation in at least three different ways. It is a question whether the conference value should not be changed with the advent of the new lunar tables.

In looking forward to future determinations of this constant, it seems to be quite possible that direct observations of the moon's parallax are likely to furnish at least as accurate a value of the earth's shape as any other method. This can be done, I believe, much better by the Harvard photographic method than by meridian observations. Two identical instruments are advisable for the best results, one placed in the northern and the other in the southern hemisphere from 60° to 90° apart in latitude, and as nearly as possible on the same meridian. On nights which are fine at both stations, from fifteen to twenty pairs of plates could be obtained. In a few months it is probable that some 400 pairs might be obtained. These should furnish a value for the parallax with a probable error of about 0·02″, and a value for the ellipticity within half a unit of the denominator 294. It would be still more interesting if the two instruments could be set up on meridians in different parts of the earth. The Cape and a northern observatory, Upsala, for example, would furnish one arc; Harvard and Ariquipa or Santiago another. If it were possible to connect by triangulation Australia with the Asiatic continent, a third could be obtained near the meridian of Brisbane. Or, accepting the observed parallax and the earth's ellipticity, we could find by observation the lengths of long arcs on the earth's surface with high accuracy.

In any case, I believe that the time must shortly come when the photographic method of finding the moon's place should be taken up more extensively, whether it be used for the determination of the moon's parallax and the earth's ellipticity or not. The Greenwich meridian observations have been, and continue to be, a wonderful storehouse for long series of observations of the positions of the sun, moon, planets, and stars. In the United States, Harvard Observatory has adopted the plan of securing continuous photographic records of the sky, with particular reference to photometric work. Under Prof. Pickering it will also continue the photographic record of the moon's position so long as arrangements can be made to measure the plates and compute the moon's position from them.

In spite of the fact that Harvard Observatory has undertaken to continue for the present the work of photographing the moon's position, I believe that this method should find a permanent home in a national observatory. It has already shown itself capable of producing the accuracy which the best modern observations of Greenwich can furnish, and no higher praise need be given. If this home could be found in the southern hemisphere, and more particularly in Australia, other advantages would accrue.

But we should look for more than this. In an observatory the first duty of which might be the securing of the best daily records of the sky, the positions of the sun, stars, planets, a couple of plates of the moon on every night when she is visible would be a small matter. What is needed is an organisation so constructed as to be out of the reach of changing governmental policy, with a permanent appropriation, and a staff of the highest character removed from all political influences. It could render immense service to astronomers, not only in the Empire, but all over the world. The pride which every Englishman feels who has to work with the records of the past furnished by Greenwich would in course of time arise from the work of a similar establishment elsewhere. Those of us who live in a community which, reckoning by the age of nations, is new, know that, in order to achieve objects which are not material, sacrifices must be made; but we also know that such sacrifices are beneficial, not only in themselves, but as exerting an indirect influence in promoting the cause of higher education and of scientific progress in every direction. In saying this, I am not advocating the cause of the few, but of the majority; the least practical investigations of yesterday are continually becoming of the greatest practical value to-day.

No address before this section is complete without some speculation and a glance towards the future. I shall indulge in both to some small extent before closing. I have shown you what the outstanding residuals in the moon's motion are: they consist mainly of long-period fluctuations in the mean longitude. I have not mentioned the secular changes because the evidence for them does not rest on modern observations, but on ancient eclipses, and these are matters too debatable to discuss in the limited time allotted to me for this address. It may be said, however, that the only secular motion which is capable of being determined from the modern observations, and is not affected by the discussion of ancient eclipses—namely, the secular motion of the perigee—agrees with its theoretical value well within the probable error. With this remark I pass to the empirical terms.

These unexplained differences between theory and observation may be separated into two parts. First, Newcomb's term of period between 250 and 300 years and coefficient 13″, and, secondly, the fluctuations which appear to have an approximate period of sixty to seventy years. The former appears to be more important than the latter, but from the investigator's point of view it is less so. The force depends on the degree of inclination of the curve to the zero line, or on the curvature, according to the hypothesis made. In either case the shorter period term is much more striking, and, as I have pointed out on several occasions, it is much more likely to lead to the sources of these terms than the longer period. It is also, at least for the last sixty years, much better determined from observation, and is not likely to be confounded with unknown secular changes.

Various hypotheses have been advanced within the last few years to account for these terms. Some of them postulate matter not directly observed, or matter with unknown constants; others, deviations of the Newtonian law from its exact expression; still others, non-gravitational forces. M. St. Blancat[6] examines a variety of cases of intramercurial planets, and arrives at the conclusion that such matter, if it exists, must have a mass comparable with that of Mercury. Some time ago I examined the same hypothesis, and arrived at similar results. The smallest planet with density four times that of water, which would produce the long inequality, must have a disc of nearly 2″ in its transit across the sun, and a still larger planet would be necessary to produce the shorter period terms. But observational attempts, particularly those made by Perrine and Campbell, have always failed to detect any such planet, and Prof. Campbell is of the opinion that a body with so large a disc could scarcely have been overlooked. If we fall back on a swarm instead of a single body, we replace one difficulty by two. The light from such a swarm would be greater than that from a single body, and would therefore make detection more likely. If the swarm were more diffused we encounter the difficulty that it would not be held together by its own attraction, and would therefore soon scatter into a ring; such a ring cannot give periodic changes of the kind required.

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[6] *Annales de la Faculté des Sciences de Toulouse*, 1907.

The shading of gravitation by interposing matter, *e.g.* at the time of eclipses, has been examined by Bottlinger.[7] For one reason alone, I believe this is very doubtful. It is difficult to see how new periodicities can be produced; the periods should be combinations of those already present in the moon's motion. The sixty to seventy years' fluctuation stands out in this respect because its period is not anywhere near any period present in the moon's motion or any probable combination of the moon's periods. Indeed, Dr. Bottlinger's curve shows this: there is no trace of the fluctuation.

Some four years ago I examined[8] a number of hypotheses. The motions of the magnetic field of the earth and of postulated fields on the moon had to be rejected, mainly because they caused impossible increases in the mean motion of the perigee. An equatorial ellipticity of the sun's mass, combined with a rotation period very nearly one month in length, appeared to be the best of these hypotheses. The obvious objections to it are, first, that such an ellipticity, small as it can be (about 1/20,000), is difficult to understand on physical grounds, and, secondly, that the rotation period of the nucleus which might be supposed to possess this elliptic shape in the sun's equator is a quantity which is so doubtful that it furnishes no help from observation, although the observed periods are well within the required limits. Dr. Hale's discovery of the magnetic field of the sun is of interest in this connection. Such a field, of non-uniform strength, and rotating with the sun, is mathematically exactly equivalent to an equatorial ellipticity of the sun's mass, so that the hypothesis might stand from the mathematical point of view, the expression of the symbols in words being alone different.

The last published hypothesis is that of Prof. Turner,[9] who assumes that the Leonids have finite mass, and that a big swarm of them periodically disturbs the moon as the orbits of the earth and the swarm intersect. I had examined this myself last summer, but rejected it because, although it explained the straight line appearance of the curve of fluctuations, one of the most important of the changes of direction in this curve was not accounted for. We have the further difficulty that continual encounters with the earth will spread the swarm along its orbit, so that with this idea the swarm should be a late arrival, and its periodic effect on the moon's motion of diminishing amplitude; with respect to the latter, the observed amplitude seems rather to have increased.

The main objection to all these ideas consists in the fact that they stand alone: there is as yet little or no collateral evidence from other sources. The difficulty, in fact, is not that of finding a hypothesis to fit the facts, but of selecting one out of many. The last hypothesis which I shall mention is one which is less definite than the others, but which does appear to have some other evidence in its favour.

The magnetic forces, mentioned above, were changes in the *directions* of assumed magnetic fields. If we assume changes in the intensities of the fields themselves, we avoid the difficulties of altering portions of the moon's motion other than that of the mean motion. We know that the earth's magnetic field varies and that the sun has such a field, and there is no inherent improbability in attributing similar fields to the moon and the planets. If we assume that variations in the strength of these fields arise in the sun and are communicated to the other bodies of the solar system, we should expect fluctuations having the same period and of the same or opposite phase but differing in magnitude. It therefore becomes of interest to search for fluctuations in the motions of the planets similar to that found in the moon's orbit. The material in available form for this purpose is rather scanty; it needs to be a long series of observations reduced on a uniform plan. The best I know is in Newcomb's "Astronomical Constants." He gives there the material for the earth arranged in groups of a few years at a time. The results for Mercury, given for another purpose, can also be extracted from the same place. For Venus and Mars, Newcomb unfortunately only printed the normal equations from which he deduces the constants of the orbit.

On the screen is shown a slide (see p. 190) which exhibits the results for the Earth and Mercury compared with those for the moon. In the uppermost curve are reproduced the minor fluctuations of the moon shown earlier; the second curve contains those of the earth's longitude; the third, those of Mercury's longitude. (By accident the mean motion correction has been left in the Earth curve; the zero line is therefore inclined instead of being horizontal.) It will be noticed that the scales are different and that the Earth curve is reversed. In spite of the fact that the probable errors of the results in the second and third curves are not much less than their divergences from a straight line, I think that the correlation exhibited is of some significance. If it is, we have here a force the period of which, if period in the strict sense it has, is the same as that of the effect: the latter is not then a resonance from combination with another period. We must therefore look for some kind of a surge spreading through the solar system and affecting planets and satellites the same way but to different degrees.

The lowest curve is an old friend, that of Wolf's sunspot frequency, put there, not for that reason, but because the known connection for the last sixty years between sunspot frequency and prevalence of magnetic disturbance enables us with fair probability to extend the latter back to 1750. With some change of phase the periods of high and low maxima correspond nearly with the fluctuations above. The eleven-year oscillation is naturally eliminated from the group results for the Earth and Mercury. One might expect it to be present in the lunar curve, but owing to its shorter period we should probably not obtain a coefficient of more than half a second. Notwithstanding this fact, it is a valid objection to the hypothesis that there is no evidence of it in the moon's motion. Reasons may exist for this: but until the mechanism of the action can be made more definite it is scarcely worth while to belabour the point.

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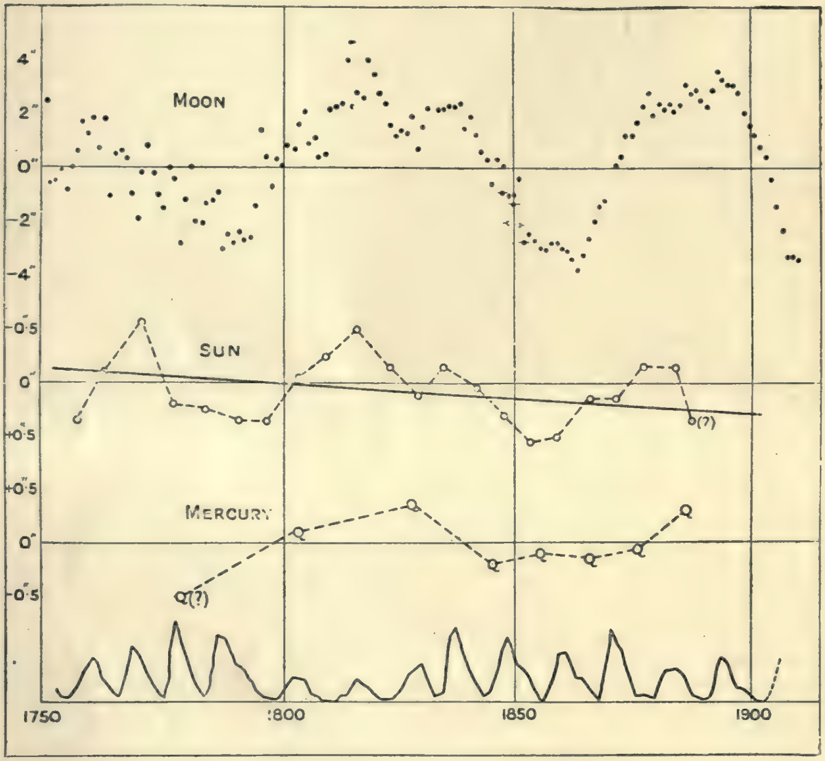
[7] *Diss.*, Freiburg i., Br., 1912.
[8] *Amer. Jour. Sc.*, vol. xxix.
[9] *Monthly Notices*, December, 1913.

The hypothesis presents many difficulties. Even if one is disposed to admit provisionally a correlation between the four curves—and this is open to considerable doubt—it is difficult to understand how, under the electron theory of magnetic storms, the motions of moon and planets can be sensibly affected. I am perhaps catching at straws in attempting to relate two such different phenomena with one another, but when we are in the presence of anomalies which show points of resemblance and lack the property of analysis into strict periodic sequences some latitude may be permissible.



In conclusion, what, it may well be asked, is the future of the lunar theory now that the gravitational effects appear to have been considered in such detail that further numerical work in the theory is not likely to advance our knowledge very materially? What good purpose is to be served by continuous observation of the moon and comparison with the theory? I believe that the answer lies mainly in the investigation of the fluctuations already mentioned. I have not referred to other periodic terms which have been found because the observational evidence for their real existence rests on foundations much less secure. These need to be examined more carefully, and this examination must, I think, depend mainly on future observations rather than on the records of the past. Only by the greatest care in making the observations and in eliminating systematic and other errors from them can these matters be fully elucidated. If this can be achieved and if the new theory and tables serve, as they should, to eliminate all the known effects of gravitation, we shall be in a position to investigate with some confidence the other forces which seem to be at work in the solar system and at which we can now only guess. Assistance should be afforded by observations of the sun and planets, but the moon is nearest to us and is, chiefly on that account, the best instrument for their detection. Doubtless other investigations will arise in the future. But the solution of the known problems is still to be sought, and the laying of the coping stone on the edifice reared through the last two centuries cannot be a simple matter. Even our abler successors will scarcely exclaim, with Hotspur,

> "By heaven, methinks, it were an easy leap
> To pluck bright honour from the pale-faced moon."

They, like us and our predecessors, must go through long and careful investigations to find out the new truths before they have solved our difficulties, and in their turn they will discover new problems to solve for those who follow them:—

> "For the fortune of us, that are the moon's men, doth ebb and flow like the sea, being governed, as the sea is, by the moon."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. H. L. SMITH, formerly lecturer in chemistry at King's College, London, and in applied chemistry at King's College for Women, has succeeded Prof. A. W. Crossley in the chair of chemistry at the School of Pharmacy of the Pharmaceutical Society.

A COURSE of eight advanced lectures on the structure of crystals, will be given at the Battersea Polytechnic, London, S.W., by Dr. T. Martin Lowry, on Fridays, commencing October 23, at 7 p.m. The nominal fee for the whole course is one shilling.

A COURSE of eight public lectures will be given in the botanical department of University College (University of London), on the rôle of plants in the protection and growth of the shore, by Prof. F. W. Oliver, on Fridays, at 5 p.m., beginning to-morrow, October 16. The course is addressed to maritime engineers, botanists, and others interested in the phenomena of the shore.

MR. ERNEST J. EDWARDS has been appointed head of the Department of Geology in the Royal Technical College, Glasgow. This position was recently created by the subdivision of the Department of Mining and Geology. Mr. Edwards is a graduate of Leeds and of Manchester, and for some years past has been assistant lecturer and demonstrator in geology at University College, Cardiff.

A REUTER message from Cape Town on October 8 states that the report of the Government Commission dealing with the University question has been issued. The report recommends the establishment of two universities, at Cape Town and Pretoria, composed of constituent colleges. The central seat of the reconstituted Cape University will be Groote Schuur, where it is proposed to erect two university buildings, designated the Wernher Hostel and Beit Hostel, for which 350,000*l*. of the Wernher-Beit gift of half a million will be utilised. The remainder of the gift it is proposed to devote to the other centres. The Commission suggests that the Pretoria college shall embrace the Transvaal, the Free State, and Natal.

THE calendar for the year 1914 of the National University of Ireland is now available. In it are printed the Irish Universities Act, 1908, the charter of the University and the various statutes. It will be remembered that the constituent colleges of the University are University College, Dublin; University College, Cork; and University College, Galway. In addition, St. Patrick's College, Maynooth, is a recognised college of the University. There are eight faculties in the University, namely, arts, philosophy and sociology, Celtic studies, science, law, medicine, engineering and architecture, and commerce. Full particulars are given as to the conditions under which degrees in these faculties are conferred, and also detailed information of the regulations and courses of the constituent colleges.

INTERESTING details as to the provision of facilities for higher instruction in agriculture for the counties in the north of Scotland are given in the 1914–15 calendar of the North of Scotland College of Agriculture. The classes of the college are held in the University of Aberdeen, except those in agricultural and field engineering, which are held in Robert Gordon's Technical College. Classes are arranged for the benefit of every section of the agricultural community, and there are courses of varying lengths at different seasons of the year, so that all grades of agricultural workers may utilise their leisure periods to the best advantage. The governors have acquired a college farm where experiments and demonstrations are carried out. Experimental plots, an experimental and demonstration garden, and a horticultural department are in course of construction. It is also intended to carry on feeding and other experiments upon stock. The farm is conveniently situated about five miles from Aberdeen. Students are expected to familiarise themselves with the experimental and other work upon the farm, on which demonstrations are carried out. There is a large area of timber, including both coniferous and hard wood trees. This is to be made use of for the purposes of the forestry department.

THE Department of Agriculture and Technical Instruction for Ireland has issued, for the present session, its programme of experimental science, drawing, manual instruction, and domestic economy for day secondary schools in Ireland, and it contains an explanatory circular and regulations. It is interesting to note in the circular to managers and principals of schools that they are informed that the efficiency of instruction will be tested by inspection, as a rule, without notice. It is, however, proposed that special inspections of a more thorough character shall be held, of which due notice will be given to the school managers. It is intended that such inspections shall not, as a rule, be held more frequently than once in three years for any one school. During the latter part of the school session notice will be given of a visit mainly for the purpose of holding the qualifying practical tests for candidates for honours. At any visit it will be within the discretion of the inspector to test any or all of the classes by practical exercises in the laboratory; by the examination of notebooks, etc.; by *viva voce* examination of classes or of individuals; by written examinations, or by a combination of these methods. The courses of instruction in these schools includes a preliminary obligatory two years' course, which may vary according to the character of the school, but must include experimental science and drawing. In subsequent years as many as three of a large number of special courses in pure and applied science may be taken, and, in the circumstances detailed, grants may be earned on the instruction.

A COPY has reached us of the forty-first annual report of the Canterbury College, of the University of New Zealand, together with a statement by the chairman of the governors and the accounts for the year 1913. Attached to the balance-sheet is a return showing the value of the various buildings and sites to be 129,794*l*. The total receipts from current revenue for the year amounted to 40,694*l*., while the expenditure totalled 36,204*l*., the surplus of income amounting to 4490*l*., of which sum 3098*l*. was utilised in reducing overdraft. Grants and subsidies from the Government totalled 11,372*l*., of which 3365*l*. was contributed towards the cost of new buildings. The total amount expended on salaries was 23,199*l*. Last year negotiations were being entered into with the governors of the Royal Holloway College with the view of a scholarship being established there in connection with Canterbury College to enable women students from the latter to continue their university studies at the London University as a post-graduate course. Such arrangements are now completed, the governors of the Holloway College have set aside a scholarship of 50*l*. per annum for the purpose. This has been subsidised by the governors of Canterbury College with 100*l*. per annum for two years, renewable for a third year if the home authorities recommend the extension of their scholarship. The chairman directed attention to the fact that the museum in connection with the college suffers financially from the fact that it is impossible to allocate a sufficiently large sum from its special source of revenue to meet even necessary requirements, and when extra expenditure becomes an absolute necessity, the amount set aside for maintenance will have to be curtailed. If no change takes place, it will become increasingly difficult to keep it in the position of being one of the leading museums south of the line, while the question of an additional wing seems for the present to be entirely beyond available resources.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 28.—M. P. Appell in the chair.—Remarks by M. Edmond **Perrier** on the life work of the late M. Jean Pérez.—P. **Puiseux**: The photographs of the Delavan comet 1913*f*, obtained at the Paris Observatory with the Henry-Gautier equatorial. From these photographs, taken September 5–6, the necessary elements can be obtained for determining very exactly two positions of the comet.—J. **Boussinesq**: The approximate evaluation of the constant of filtration μ, for a filtering medium composed of spherical grains of a given diameter.—M. **Coggia**: Observations of the Delavan comet made at the Observatory of Marseilles with the comet-finder. Positions are given for September 14–15 (two observations), 17–18, with positions of the comparison stars. The comet is visible to the naked eye with a tail of about 1°.—MM. **Luizet** and **Guillaume**: Observation of the solar eclipse of August 21, 1914, made at the Observatory of Lyons.—D. **Pompeiu**: A problem relating to abstract ensembles.—Ch. **Tanret**: The plurality of the amyloses. Determinations of the absolute and relative percentage of amyloses dissolved by water at different temperatures in sixteen different kinds of starches.

BOOKS RECEIVED.

Canada. Department of Mines. Geological Survey. Memoir 39. No. 35. Geological Series. Kewagama Lake Map-Area, Quebec. By M. E. Wilson. Pp. vi+139+plates+map. No. 24. Geological Series. The Archæan Geology of Rainy Lake, Re-studied by A. C. Lawson. Pp. vii+115+map. (Ottawa: Government Printing Bureau.)

The Mechanical Properties of Wood. By Prof. S. J. Record. Pp. xi+165. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 7*s.* 6*d.* net.

Modern Tunneling, with Special Reference to Mine and Water-Supply Tunnels. By D. W. Brunton and J. A. Davis. Pp. vi+450. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 15*s.* net.

Forage Plants and their Culture. By C. V. Piper. Pp. xx+618. (London: Macmillan and Co., Ltd.) 7*s.* 6*d.* net.

Pasteur, and after Pasteur. By S. Paget. Pp. xii+152. (London: A. and C. Black.) 3*s.* 6*d.* net.

Experiments: a Volume for all who are Interested in Progress. By P. E. Edelman. Pp. 256. (Minneapolis: P. E. Edelman.) 1.50 dollars.

A History of the Teaching of Domestic Economy. By A. Yoxall. Pp. 56. (London: Knopp, Drewett and Sons, Ltd.) 6*d.*

Transactions of the Royal Scottish Arboricultural Society. Vol. xxviii. Part 2. (Edinburgh: Douglas and Foulis.) 5*s.*

Annals of the South African Museum. Vol. x. Part xi. (London: West, Newman and Co.) 18*s.*

Quarterly Journal of the Royal Meteorological Society. Vol. xl. No. 172. (London: E. Stanford, Ltd.) 5*s.*

Canada. Department of Mines. Geological Survey. Museum Bulletin. No. 2. Pp. 140. (Ottawa: Government Printing Bureau.)

Board of Education. Reports for the Year 1912–13 from those Universities and University Colleges in Great Britain which are in Receipt of Grant from the Board of Education. Vol. i. Pp. xxxi+489. Vol. ii. Pp. 484. (London: H.M.S.O.; Wyman and Sons, Ltd.) 2*s.* 1*d.* and 2*s.* respectively.

Quain's Elements of Anatomy. Eleventh edition. Edited by Sir E. A. Schäfer, Prof. J. Symington, and Prof. T. H. Bryce. Vol. ii., part ii. Splanchnology. By J. Symington. Pp. x+392. (London: Longmans and Co.) 10*s.* 6*d.* net.

Cocoa. By Dr. C. J. J. van Hall. Pp. xvi+515. (London: Macmillan and Co., Ltd.) 14*s.* net.

Highways and Byways in Lincolnshire. By W. F. Rawnsley. Pp. xviii+519. (London: Macmillan and Co., Ltd.) 5*s.* net.

Zoological Philosophy: an Exposition with Regard to the Natural History of Animals, etc. By J. B. Lamarck. Translated by H. Elliott. Pp. xcii+410. (London: Macmillan and Co., Ltd.) 15*s.* net.

An Introduction to the Study of Physical Metallurgy. by Dr. W. Rosenhain. Pp. xxii+368. (London: Constable and Co., Ltd.) 10*s.* 6*d.* net.

On Pharmaco-Therapy and Preventive Inoculation Applied to Pneumonia in the African Native. By Sir A. E. Wright. Pp. ix+118. (London: Constable and Co., Ltd.) 4*s.* 6*d.* net.

The Electrical Conductivity and Ionization Constants of Organic Compounds. By Dr. H. Scudder. Pp. 568. (London: Constable and Co., Ltd.) 12*s.* 6*d.* net.

The Curves of Life. By T. A. Cook. Pp. xv+479. (London: Constable and Co., Ltd.) 12*s.* 6*d.* net.

Antarctic Adventure. By R. E. Priestley. Pp. 382. (London: T. Fisher Unwin.) 15*s.* net.

Wireless Telegraphy. By A. B. Rolfe-Martin. Pp. vii+256. (London: A. and C. Black.) 5*s.* net.

The Geographic Society of Chicago. Bulletin No. 4. The Weather and Climate of Chicago. By Prof. H. J. Cox and J. H. Armington. Pp. xxv+375. (Chicago, Ill.: University of Chicago Press.) 12*s.* net.

DIARY OF SOCIETIES.

TUESDAY, OCTOBER 20.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Double Walled Towers of Scotland. Exhibition of Specimens: D. MacRitchie.

WEDNESDAY, OCTOBER 21.

ENTOMOLOGICAL SOCIETY, at 8.—Hawaiian Ophioninæ: Dr. R. C. L. Perkins.

FRIDAY, OCTOBER 23.

PHYSICAL SOCIETY, at 8.—Presidential Address: Ionisation: Sir J. J. Thomson.

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THURSDAY, OCTOBER 22, 1914.

EXPERIMENTAL AND PHILOSOPHICAL BIOLOGY.

(1) *Experimental Zoologie.* By Dr. Hans Przibram. 4. Vitalität. (Lebenszustand.) Pp. viii+179+x plates. (Leipzig and Wien: Franz Deuticke, 1913.) Price 10 m.

(2) *Mechanism, Life and Personality.* An Examination of the Mechanistic Theory of Life and Mind. By Dr. J. S. Haldane. Pp. vii+139. (London: John Murray, 1913.) Price 2*s.* 6*d.* net.

(1) FROM the point of view of an experimental zoologist, Dr. Przibram has made a very valuable study of the distinctive characters of organisms, which may be ranked in three groups—structural, chemical, and functional. Organisms have a heterogeneous structure, showing at least cytoplasm and nucleoplasm, and they develop by self-differentiation. Organisms also show chemical differentiation, being built up of heterogeneous proteids in a colloidal state. Organisms grow in an active way; they utilise food different from themselves; they multiply in a manner certainly different from the division of crystals; they often show apparently spontaneous movements; and they have an unusual power of preserving impressions of previous states. It is interesting to notice how little agreement there is as yet among biologists as to the best way of stating these general characters of organisms. Przibram's is marked by a desire to avoid any exaggeration of the apartness of living creatures or any discouraging of the methods of mechanistic interpretation.

It is experimentally possible to mimic, with inorganic materials, the growth, movements, and even division of simple organisms, and a bowl of gelatine may illustrate the power of retaining traces of previous influences after the original conditions have been restored. Many beautiful experiments point to the conclusion that the geometrical forms displayed by many organisms, *e.g.* in their shells and skeletal parts, are expressions of the properties of the "aggregation-state" of the protoplasm. The polarity, likewise, of an organism admits of interpretation in terms of the "layering" or zonal distribution of different kinds of substances, and in similar ways.

The rapid advances of synthetic chemistry (only possible, however, through the directing intelligence of the chemist), show that we must not make too much of the chemical complexity of the proteids so characteristic of organisms; the difficulty as to the optically active nature of vital organic substances may be overcome; and the fact that fermentation- and oxidation-processes are slower when the living vehicles, *e.g.* yeast and red blood corpuscles, are absent, may be due to the greater concentration afforded by the organisation of the living cells. Living implies action and reaction between the organism and its environment; the continuance of the creature's activity depends on its structural organisation and on its specific series of chemical processes; violent death ensues when changes in the complex environment (chemical reagents, humidity, concentration, pressures, gravity, electricity, radiant energies, and temperature) fatally disturb the chemical processes, or break down the structure, or prevent the persistence of the organisation by disarranging the chemical routine.

Przibram has made many observations on the rate of growth in different types, and his general result takes us back to Herbert Spencer. A doubling of the mass of the living cell leads to the break-down of that cell, and the process is comparable to the "autokatalysis" observed in some non-vital chemical transformations. Surely in its movements, at least, the animal is spontaneous and unique. But the author bids us consider all the taxisms and tropisms—the inevitable responses which the creature makes in response to external stimuli—of light, heat, pressure, humidity and so on. He seems to us to lay on the shoulders of taxisms and tropisms a burden heavier than they can bear, and we do not think that what Jennings observed of an amœba on the hunt can be fully redescribed along these lines. It is plain, however, that the interpretation in terms of taxisms and tropisms must continue to be worked for all it is worth until we get quite below the stage of opinions. In answer to the common criticism that we see different answers given by the same or similar organisms to precisely similar stimuli, Przibram admits that we must take account of the physiological condition of the organism as affected by previous experiences, both personal and racial. This is a crucial point—whether inorganic bodies can be said to have "duration" in Bergson's sense—the power of continuing the past into the present. Przibram admits that living creatures have the power of registering the past in a notably high degree, but he declines to credit them with the exclusive possession of this quality, recalling for instance the facility with which a piece of steel is magnetised after it has been magnetised before.

As regards transformations of energy, organisms are marvellous engines, but they conform to the laws of thermodynamics. The conclusion arrived at is that we cannot assert that there operates in organisms any form of energy which is not known in the inorganic domain. Of course, we have our psychical life, but can we say that this makes a thoroughgoing distinction between organisms and inanimate bodies? How can we tell? Thus there ends a masterly book—scholarly, keenly critical, and rigidly objective. We do not think that the author shows the sufficiency of chemico-physical formulæ for the description of the phenomena of life, but we have the strongest admiration for his searching criticism of the doctrine of the autonomy of the organism. His book should be read along with Johnstone's "Philosophy of Biology."

(2) "The time is now more than ripe," Dr. Haldane writes, "for bringing the great biological movement of the nineteenth century into definite relation with the main stream of human thought," and his lectures form an important contribution towards the fulfilment of this task. The first lecture contrasts the mechanistic and the vitalistic interpretations. The former is certainly good so far as it goes, for the living creature can be usefully considered as a very complex material system, conforming to the laws of dynamics, exhibiting physical and chemical processes that are in line with those of the inorganic world, and as for consciousness (if that be demonstrable) it makes no difference to the energy balance whether the organism is conscious or not. It is true that the activities of the organism are very wonderfully co-ordinated towards securing the survival of the individual and the race, but it is replied that there are effective nervous and chemical means which secure this co-ordination, and have been wrought out in the course of untold ages of variation and selection. It has to be admitted, however, that what goes on is more complicated than the working of any machine known to man; that mechanical interpretations of such functions as excretion and respiration have had to be abandoned from time to time because they did not cover the facts; that heredity, variation, and development seem facts *per se*; and that the organism is strangely autonomous. For these and similar reasons there is periodic reaction from mechanism to vitalism.

"Vitalism assumes that the intimate processes are guided or controlled by an influence which is manifested only in living organisms, and which acts in a manner wholly different from anything known in the inorganic world."

To Dr. Haldane the theory of vitalism is no more acceptable than that of mechanism. For if a vital principle controls what goes on in the organism, can it do so without a breach in the conservation of energy; and if it guides, how does it know how to do it? The hypothetical vital principle is unproved, unintelligible, and useless. In this chapter, the answer to Driesch's argument from embryonic development seems to us very far from clear.

The second lecture contains a criticism of the mechanistic theory. It has been useful in stimulating research, but it is inadequate for the redescription of what is essentially vital. A minute increase in the hydrogen ion concentration of the blood induces an intense activity of the respiratory centre, but we do not know the chain of events between the stimulus and the response.

"In the case of stimulus and response there is in reality no experimental evidence whatsoever that the process can be understood as one of physical and chemical causation."

Or what are we to make of the "recovery of functional activity after destruction of centres or nerve paths on which this activity normally depends?" Moreover, the fact is that "physico-chemical explanations of elementary physiological processes are as remote as at any time in the past." Even if we could picture the vast assemblage of delicately-adjusted cell-mechanisms, keeping themselves in working order year after year, keeping in exact co-ordination with all the other cell-mechanisms, and so on, how can we conceive of this condensed into a germ-cell, uniting with another germ-cell, and then developing afresh. And the difficulty of thinking mechanically of reproduction recurs when we picture the continual renewal of cells and plasm within the body, the ceaseless work of maintaining a structural and functional specificity. Dr. Haldane concludes that "the phenomena of life are of such a nature that no physical or chemical explanation of them is remotely conceivable." In speaking of the mechanistic view of the germ-plasm, the author says, p. 58: "On the one hand we have to postulate absolute definiteness of structure, and on the other absolute indefiniteness." But it seems to us that the word indefiniteness is here used in a sense not inconsistent with definiteness, namely, in reference to the number of divisions that may occur. If we understood *one* division, we should not boggle over an indefinite number of them.

In his third lecture Dr. Haldane turns the tables on the mechanists. The physical and chemical concepts are, after all, but working hypotheses; the notion of a real and self-existent material universe does not survive Hume's criticism. In any case, when we pass to the world of organisms we need new concepts, especially that of the living organism, a specific entity, actively maintaining and reproducing its individual structure, with functions which are determined in definite relation to the whole unified activity, an autonomous active whole. "The conception of organism is a higher and more concrete conception than that of matter and energy." In the ruins of the atomic theory, it is already being extended to the whole of nature. "We are not seeking to reduce the organic to the inorganic, but the inorganic to the organic." To us it appears unnecessarily dogmatic to assert that "there is not the remotest possibility of deriving the organic from the inorganic." Would it not serve to say that we cannot think of the origin of organisms from the inorganic world, if the reality of the latter is supposed to be exhausted by the current concepts of chemistry and physics? And are we not bound in fairness to admit that while the physical and chemical formulæ need not be regarded as exhausting the reality of the inorganic world, they serve for certain practical purposes exceedingly well, and must bear a definite relation to reality since we successfully stake our lives and our reputations (as scientific prophets) on their validity.

The fourth lecture finds a philosophical foothold in the recognition of personality as the central fact in the world. We may consider a man as a material system weighing seventy kilogrammes, and this partial and abstract way of looking at him is sometimes of use; we may also consider him as an organism, maintaining specific structure and activity, and this is also useful; but we get nearest the real man when we know him as a person. Personality—mere organism—matter: "the relation is simply one of different degrees of nearness to reality in the manner in which phenomena are described." But personality is more than an individual concept; "the personality of any individual is the spiritual inheritance of ages; the individual participates in the life of the species; personality includes within itself our whole universe. We know extremely little about what we call matter; "the reality behind the appearance of a physical world has and can have no existence apart from personality." And thus, as the physiologist in his first two lectures sought to lead us away from the error of mechanism, so the philosopher in the last two seeks to lead us to the conclusion that the world, with all that in it is, is a spiritual world. But the realist has also something to say for himself!

FUELS FOR POWER PRODUCTION.

Fuel: Solid, Liquid, and Gaseous. By J. S. S. Brame. Pp. xv + 372. (London: Edward Arnold, 1914.) Price 12*s.* 6*d.* net.

MR. BRAME'S treatise is one of a long succession of books dealing with the general subject of fuels, but in view of the wonderful rapidity with which processes relating to fuel manufacture and its preparation are changing, and of the new uses to which the fuels are put when made, there is ample room for new-comers. The author writes specially for the large class of readers to whom power production is of chief importance, and he has produced a volume which will be an extremely valuable addition to their bookshelves.

The subject divides itself naturally into three divisions—solid, liquid, and gaseous; Mr. Brame discusses each separately, and adds a section on fuel analysis, calorimetry, and the control of fuel supply. Under the title "Solid Fuels" are included wood, peat, coal, coke, coalite, and the minor fuels; liquid fuels include petroleum and tar oils with their derivatives, together with alcohol. The longest section, that on gaseous fuels, contains an account of the manufacture and properties of water gas, of Siemens and Dowson gas, and of blast-furnace and coke-oven gases.

Well-informed as the author appears generally to be, he makes a strange omission when discussing the velocity of flame propagation in an explosive mixture—the stranger in a book bearing specially in view the production of power—in that he omits reference to the striking influence on this velocity of "turbulence" in the gaseous mixture. As Clerk has shown in the reports of the Gaseous Explosions Committee, turbulence is of first importance in influencing the velocity with which the explosion spreads to all parts of the gas, and that except for this no high-speed gas or petrol engine would be able to run at the speeds necessary for their effective use.

The Bonecourt system of surface combustion is described briefly, but perhaps as fully as can be expected in a book dealing with fuel itself rather than with its manner of use. The author compares the 90 per cent. efficiency of this system when applied to the heating of steam boilers with the 55 to 65 per cent. which is usual with coke-oven or blast-furnace gases used in the older way. This improved method of steam raising is potentially of great practical importance, and we are glad the author has found space to include a number of interesting efficiency figures.

Under the title "Economic Aspects of Liquid Fuel" the author discusses the present situation in which fuel users are placed owing to the rapid change in price. He reiterates the relative insignificance of the annual oil output compared with the coal output, and affirms his belief in the possibility and the economic advisability of the production of alcohol for power uses. This is one of the best parts of the book, and the author is assuredly correct in saying of industrial alcohol:

"Its adoption would give encouragement to agriculture; it would provide a national weapon to fight artificial (or economic) shortage of other fuel for internal combustion engines; indirectly it would encourage the further development of a big and growing branch of engineering, the success of which is impossible without an assured supply of fuel at a reasonable cost."

H. E. W.

MODERN PRACTICE IN THE EXTRACTION OF METALS FROM THEIR ORES.

The Metallurgy of the Non-Ferrous Metals. By Prof. W. Gowland. Pp. xxvii + 496. (London: C. Griffin and Co., Ltd., 1914.) Price 18*s*. net.

THIS book is a most valuable addition to the series of metallurgical text-books published by Messrs. C. Griffin and Co. It gives in a concise but wonderfully complete form the up-to-date practice in the extraction of the following metals from their ores: copper, lead, gold, silver, platinum, mercury, zinc, cadmium, tin, nickel, cobalt, antimony, arsenic, bismuth, and aluminium. Under the heading of each metal are considered (1) its physical and chemical properties; (2) the alloys of which it is the chief constituent; (3) the composition and applications of commercial brands; (4) the chief ores and processes by which the metal is extracted from them and rendered suitable for industrial or other purposes; (5) the principles and conditions on which the success of these processes depends; and (6) examples of actual practice in important extraction works. The author states that special attention has been given to the metallurgy of gold, silver, copper, and lead, which undoubtedly constitute the most important members of the above group. This statement is thoroughly justified, for, so far as we have been able to ascertain, every important modern successful process has received attention.

In writing this book the author has had in view not only the student engaged in a course of metallurgical training, but also the man who is actually dealing with practical problems; and he is particularly well qualified to present both these important aspects of the subject. It is perfectly true, as he points out, that much valuable information with regard to modern metallurgical practice may be found in technical periodicals and the proceedings of societies. Those who have the opportunity of consulting such publications will, we think, find his critical comparisons of similar processes of great value, while to the man whose time is limited or who has no technical library within reach the book will be one of the most valuable that has ever been published. The clear and full table of contents enables a reference to any particular process, and, indeed, to any special feature of it, to be readily made.

The author writes with rare, indeed, almost unique, knowledge of the metallurgy of copper, and his mastery of the subject cannot be better illustrated than by mentioning that in the compass of eighty-one pages every important aspect is dealt with. The ore now being pyritically smelted at the Tennessee Copper Co.'s works at Copperhill runs rather lower in copper than the figure 2 to 2½ per cent. mentioned by him (p. 100); it does not exceed 1·9 per cent., and is tending to become even lower in grade. We think that the Chilian Mill might have received more attention than the three lines devoted to it on p. 208. At the present time almost, if not quite, all the Cripple Creek gold ores are reduced by Chilian mills, the Stamp Mill having been practically superseded in this district. Harker's value of 1710° C. is given for the melting point of platinum. It is now generally recognised that this figure, which was obtained on the thermo-electric scale by extrapolation, is too low. The value 1755° C. quoted recently by the Bureau of Standards is probably much nearer the true figure.

SCIENCE AND INDUSTRY.

The Co-operation of Science and Industry. By S. R. Illingworth. Pp. 91. (London: C. Griffin and Co., Ltd., 1914.) Price 1*s*. 6*d*. net.

THIS little book has a special interest at the present time. The author deals with the history of science as applied to industry, and while avoiding any violent diatribes against the supineness of the British manufacturer, he points out what may be done to recover the supremacy of our trade. The employment of more scientific men in most of our works is strongly advocated, not only of the higher class of research men, but also of the class of routine analysts. The first class is required to devise new processes along scientific lines, to discover uses and outlets for bye-products, and always to be on the look-out for methods for gaining the maximum yield of finished products at the minimum of cost.

"To many business men the employment of such a man may appear a luxury; almost a gamble! The few that have such men are only employing them for some specific object, and maybe will rest content when that object is attained. Such an attitude is fatal."

If the German manufacturers had been content to take this line, the magnificent industries which they have built up would certainly not have come into existence. We have now, at this moment, an opportunity of recovering the ground we have lost.

The Government Committee on the Chemical Trades is composed of men who will command the confidence of everyone, and their recommendations will have great weight. It must not be forgotten, however, that nearly all trades would be benefited by scientific help. The attitude of mind induced by scientific education is just the one required for the successful development of a business. If the manufacturers as a whole would realise this, they would see to it that their sons or those who are to carry on their business, have a thoroughly good scientific education, such as may now be got at many of the Universities and technical colleges in the country. It is not the classical or the modern side of our schools which is going to supply the successful manufacturer of to-morrow, it is the side where a man is taught to bring all his useful knowledge to bear on the achievement of success. Mr. Illingworth's book is the most successful attempt which has been made to explain the situation, and we believe that if the Government would send a copy of the book to each manufacturer in the country, the cost would be a mere nothing compared with the effect which would be attained.

OUR BOOKSHELF.

A Little Book on Map Projection. By Mary Adams. Pp. viii + 108. (London: George Philip and Son, Ltd., 1914.) Price 2*s.* net.

It is very satisfactory to find that at the present time care is being taken that the principles of map projection are being studied as soon as the use of maps is seriously undertaken. At one time this part of their subject was much neglected by geographers, and left to those whose mathematical aptitude was especially developed. In this book Miss Adams aims at meeting the needs of the secondary and the higher elementary schools; and in clear and simple language sets forth the difficulties of an adequate cartographical representation of the earth's surface. Simple explanations are given of the principal types of projection, and then the distortion of the original spheroidal surface when it is represented on a plane surface is explained, and the compromises which have to be adopted are set forth. After this preliminary exposition, into which no mathematics enter, there follows a more detailed discussion of the principal zenithal, conical, and cylindrical projections, as well as certain special projections. These are illustrated by diagrams, and the explanation which is given of each should enable anyone to obtain a clear idea of the essential character of each kind.

A short appendix gives a more mathematical account of Mercator's, the Zenithal, and Mollweide's projection, but with this exception no demand of any but elementary mathematical knowledge is made upon the reader.

A short bibliography, which might be usefully extended by the inclusion of some well-known German and Italian works, shows the student where he may find a more advanced treatment of the subject. The book is carefully written and well adapted to those for whom it is intended, and, while it cannot give them that complete knowledge of the subject which mathematical treatment alone can supply, it will pave the way to an intelligent appreciation which is of the utmost value to all who use maps.

Chemical Engineering: Notes on Grinding, Sifting, Separating and Transporting Solids. By J. W. Hinchley. Pp. viii + 103. (London: J. and A. Churchill, 1914.) Price 2*s.* 6*d.* net.

In this series of articles, reprinted with some additions from the *Chemical World*, Mr. Hinchley provides, for the use of students intending to take up chemical engineering, a concise and practical outline of a subject of wide scope. The articles are illustrated with seventy sketches and diagrams, and their thoroughly practical character will be much appreciated by students of this branch of technology.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Fizeau's Experiment and the Principle of Relativity.

It is well known that the principle of relativity gives for the velocity of light in a moving medium the expression

$$\frac{c}{\mu} + kv, \text{ where } k = \left(1 - \frac{1}{\mu^2} - \frac{\lambda}{\mu}\frac{\delta\mu}{\delta\lambda}\right)$$

where v is the velocity of the medium, and c/μ is the velocity when at rest. The repetition of Fizeau's experiment by Michelson and Morley gave for water the value 0·434 ± 0·02 for the coefficient k, whereas the value of the theoretical coefficient, taking the known values of μ and λ for sodium light, is 0·451, which is well within the limits of the possible error.

The experiments of Gutton (*Journ. de Phys.*, ii., p. 196, 1912) show clearly that in the case of a very dispersive medium like carbon disulphide the velocity of propagation of nearly homogeneous light is the group velocity, and not that of an absolutely monochromatic train of waves. If this is universally true, as Lord Rayleigh and Gouy have predicted, then in the expression for the convection-coefficient k, the symbol μ must stand for the ratio of the velocity of light in free space to the group velocity. If we call the ordinary coefficient of refraction μ_0, we have

$$\mu = \mu_0\left(1 - \frac{\lambda}{\mu_0}\frac{\delta\mu_0}{\delta\lambda}\right);$$

neglecting the square of $\frac{\lambda}{\mu_0}\frac{\delta\mu_0}{\delta\lambda}$ (*i.e.* of 0·014) and terms of the same order, we have

$$k = 1 - \frac{1}{\mu_0^2} - \frac{\lambda}{\mu_0}\frac{\delta\mu_0}{\delta\lambda} - \frac{2\lambda}{\mu_0^3}\frac{\delta\mu_0}{\delta\lambda} + \lambda\frac{\delta}{\delta\lambda}\left(\frac{\lambda}{\mu_0}\frac{\delta\mu_0}{\delta\lambda}\right)$$

If we take the dispersion-formula of Ketteler and calculate the values of the two last terms in this expression, we find that they are respectively $+0.016$ and $+0.022$, so that the theoretical value of k becomes $6.451+0.038$, that is, 0·489. This even is in worse agreement with the experimental value 0·434 than the value 0·451 usually given, but a consideration of the experimental conditions shows that the value to be deduced is in reality 0·492, which is in excellent agreement. The argument will shortly be published in full.

E. CUNNINGHAM.

St. John's College, Cambridge, October 14.

Flint Fracture.

IT is to be regretted that the letter of Mr. Reid Moir in NATURE of September 24 has received no reply. If chemists, mineralogists, petrologists, and physicists could have been made to realise the fruitful fields for profitable and far-reaching research opened to them by this subject, our knowledge would be in a very different state to-day, and many of the contentions and mysteries would be replaced by demonstrable facts.

In all text-books we see descriptions, or references, to lydite, the touchstone of the goldsmith, and in museums and collections we see specimens bearing this name; all kinds of origins are claimed for it; sedimentary, volcanic, metamorphic, and one has even seen meteoric. In text-books we see descriptions of the pebbles in the Blackheath beds; we are told they are pebbles of flint still retaining their original black colour. As a matter of fact, they are not black flint; they are now of various colours. It is their surface that is black; the metamorphosed portion may not be thicker than tissue paper, but other examples can be found upon a sea-beach where it is an eighth of an inch thick, and from this onward until the whole is metamorphosed, and we have the jet-black mineral, which does duty under the name of lydite!

Just one more example. The same text-books describe the beautiful "Egyptian jasper"; some say the locality from which this has been derived is unknown; others venture to suggest one. One of the many metamorphoses of flint is jasperisation. We see this commence on the surface of flints (one of the things called patination); this proceeds in intensity and centrewards until the whole substance is altered, and we have the rich mottlings of yellows and browns, quite equal to those of Egypt. The so-called Egyptian jasper may be a metamorphosed British flint.

Mr. Reid Moir refers to lines radiating from the point of percussion on the fractured face of a flint; here is something for the physicist; they certainly are not "fissures," but rather lines of force (closely connected with facetted cones and stellate fracture). The best place to see these, and study them, is in asphalt or pitch. So long as the "fracture-" or "flaking-plane" maintains itself constant, *i.e.* in relation to the striking-plane, they remain fairly simple. If, however, the fracture-plane resolves, or even undulates very deeply, then a very remarkable phenomenon obtains, and the lines end in a row of cones just over the escarpment, looking like a row of pointed tents with a rope passing from the centre pole of each to the point of percussion!

The last weeks of Sir John Evans, before he took to his final bed, were spent in studying a large collection brought together to put the whole subject of lithoclasiology on a scientific footing. His last words to the collector were: "Promise me that if I do not pull through this operation, you will lose no time in publishing all this. I am certain that this is where we ought to have started sixty years ago, and no real progress will be made until we start here."

If we take half a dozen pieces of flint of exactly the same shape and size, and apply exactly the same force, administered in exactly the same manner, and of exactly the same intensity, the results may be very different in each case. Before we can argue from the effect to the cause, we must know something about the nature of the object acted upon. We must start with the origin and nature and varieties of silica, the various metamorphoses and molecular rearranging to which each variety is subject, and how each variety, in each state, responds to dynamic agency, whether administered by nature or man.

So also when we come to dynamics we must study every mechanical possibility, single them out, and name them, so that every observer may know what the other is speaking about. There must be no "peculiarities known only to the student," and "no features known only to myself." Each phenomenon must be capable of separate study, and receive a special name, so that all understand what they are talking about.

There are few who appreciate the splendid work which Mr. Reid Moir has been doing more than myself, but I am quite sure that if he were to restart the subject, on the lines here indicated, in a very short time he would regard the points he raises with very different eyes.

W. J. LEWIS ABBOTT.

8 Grand Parade, St. Leonards-on-Sea.

Filtering Power of Sand.

THE letter of Mr. C. J. Watson in NATURE for October 15, recommending that "Nachtblau" (night-blue) should be used for experiments on adsorption by sand, leads us to point out that so far back as 1909 we demonstrated before the International Congress of Applied Chemistry (Section IV.B, p. 7) the striking experiment in which a solution of this dye issues perfectly colourless after passing through a column of purified sand. Since this date the experiment has been frequently used for demonstration purposes at lectures on adsorption by ourselves and others.

We showed in 1909 the remarkable quantitative relations existing between the weight of sand and the weight of dye absorbed; each degree of fineness of the sand is characterised by a remarkably sharp coefficient of adsorption, the value $\frac{\text{weight of dye adsorbed}}{\text{weight of sand}}$ being constant for the same sand to the sixth decimal place (in one series, for example, values 0·000147 to 0·000148 being obtained). The relation of these experiments to the general theory of dyeing was dealt with in the paper cited, and also in a later communication to the Society of Chemical Industry (1912, vol. xxxi.).

W. P. DREAPER.
W. A. DAVIS.

Scientific Societies and the War.

SUGGESTIONS have recently been made that certain of our scientific societies should suspend their meetings for the present, on the ground that "it is difficult to take an interest in such things just now." To those who share this feeling, it may be worth while to point out that, as already recorded in NATURE, the Académie des Sciences held its usual meeting Paris on September 7. Under that very date, in the *Times* review of the war for September, we find the entry, "Germans reach the extreme point of their advance." Among our gallant Allies, at all events, "le tour d'ivoire ne se rend pas."

W. T. CALMAN.

British Museum (Natural History), October 16.

THE X-RAY SPECTROMETER.

IT is now well known that a homogeneous pencil of X-rays is capable of reflection by a crystal provided that the rays are directed upon the crystal at the proper angle.[1] If λ is the wave-length of the X-rays, d the spacing of the crystal planes, and θ the angle which the rays make with the planes, these quantities are connected by the relation $n\lambda = 2d\sin\theta$,[2] where n is an integer.

The object of the spectrometer is to determine the value of θ in any given case—that is to say, for a definite set of X-rays and a definite set of crystal planes. The results may be classified as follows: If we use different crystals or different faces of the same crystal, but keep the rays the same, we can compare the spacings of the various sets of planes. In this way we arrive at a knowledge of the relative positions of the atoms in the crystal—that is to say, we determine its structure.

If we use the same crystal always, but examine the angle of reflection of different homogeneous X-rays, whether from the same or from different sources, we have the means of comparing the wave-lengths of those rays. We can, in fact, analyse X-radiation in exactly the same way as an ordinary spectrometer analyses light.

The new instrument resembles the ordinary spectrometer in its general construction. To the collimator corresponds a set of narrow slits limiting a pencil of X-rays, which is directed so as to pass through the axis of the instrument. A crystal takes the place of the diffraction grating, and is mounted on a small revolving table. The crystal face or set of planes which is acting as reflector is made to contain the direction of the axis of the instrument, and the crystal is turned round the axis until the face makes the proper angle with the incident pencil. The reflected ray then enters a cylindrical ionisation chamber filled with gas which it ionises. The chamber takes the place of the ordinary telescope, and the measurement of the ionisation current by an electroscope corresponds to observation by eye or by the photographic plate.

In the drawing of Fig. 1,[3] which shows the arrangement of the apparatus in plan, Q is the antikathode of the X-ray bulb. The construction of the bulb is a little unusual in that the antikathode is placed perpendicularly to the kathode ray stream; the bulb can therefore be conveniently arranged so that the X-rays leave the antikathode at a grazing angle. The finer the angle which the rays make with the antikathode, the more nearly does the source become, effectively, a "bright" line; and the narrower the line the brighter it becomes, because the "whole illumination" given out in any direction by the spot on the antikathode is independent of the direction. The law followed is not that of the illumination by a surface of uniform luminosity, but rather that of the illumination due to a number of separate sources lying in one plane, each radiating uniformly in all directions. It corresponds to the case described by Rutherford, in which α rays are radiated from a uniform thin sheet of radio-active matter spread upon a plane surface (*Phil. Mag.*, August, 1906). The arrangement is of considerable value; the more nearly is the source a bright line parallel to the slit, the "purer" is the spectrum.

The X-ray bulb is enclosed in a wooden box heavily coated with lead. The object is to protect not merely the observer but also the sensitive apparatus. The slit through which the rays pass is only a few millimetres long and very narrow, sometimes no more than a tenth of a millimetre wide. Only a small fraction of the pencil that emerges is reflected in the best of circumstances, so that it is necessary to screen off all stray radiation with great care; it must be small in comparison with the radiation which is to be measured. The side of the box is shown on the left of the photograph of Fig. 2. Adjustable slits are placed at A where the rays leave the box, and again at B, the second slit being also capable of a movement which brings it close up to the crystal, as at B′. The crystal is shown at C, and a third slit, D, is placed just in front of the ionisation chamber.

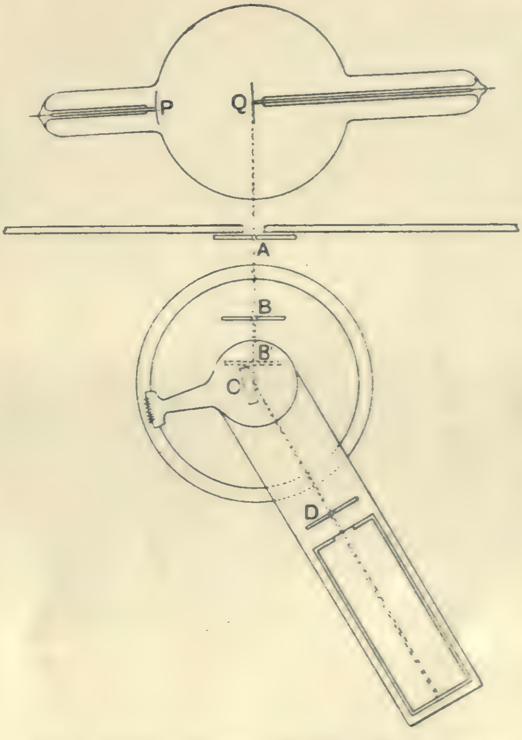

FIG. 1.—X-ray spectrometer. Plan of general arrangements.

The ionisation chamber is marked I in Fig. 2. It is a cylindrical brass chamber 15 cm. long, and is filled with some heavy gas, so that the ionisation current may be as large as possible. Sulphur dioxide is convenient in many cases, but methyl bromide is much better for rays which can excite the bromine X-rays. Such rays are, for example, given off by antikathodes of silver, rhodium, or palladium, the latter two of which have been much used in the determination of crystal structure, because they give off intense homogeneous rays and also stand up well against the bombardment by the kathode stream. The chamber I is insulated and maintained at a high potential, which drives any ionisation on to an internal electrode. The latter is connected by a fine wire which passes down inside the metal shield WW to the gold leaf electroscope (Wilson pattern) within the shield E. The connection with the electroscope terminal is made at a point lying on the axis of the spectroscope, so that the ionisation chamber I, the casing W, and the connecting wire may all revolve together about the spectrometer axis without straining the connection. The shielding is made solid and strong: it is necessary that the electrostatic screening should be perfect, and the electroscope must be protected from draughts which may cause changes in temperature.

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[1] A summary of the principles on which this experiment is based, and of the progress of its development may be found in NATURE of July 9, 1914, p. 404.

[2] *See* Proc. Camb. Phil. Soc., November 11, 1912, or Proc. Roy. Soc., April 7, 1913.

[3] From a book now in the press, to be published by Messrs. G. Bell and Sons.

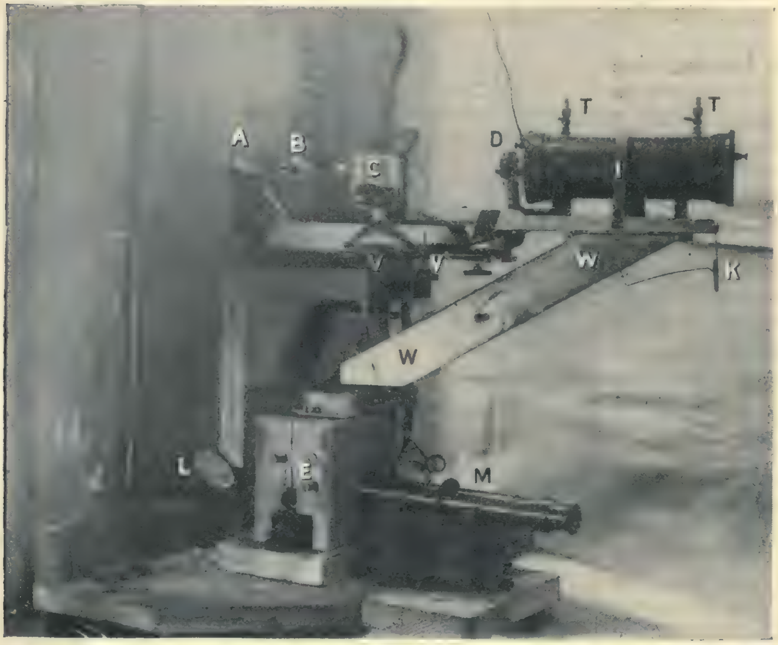


FIG. 2.—Photograph of X-ray spectrometer.

The gold leaf is illuminated by reflection from a mirror L, and viewed through a microscope M. A strong X-ray reflection will cause the leaf to move twenty or thirty scale divisions in a second.

The angular positions of the crystal and the ionisation chamber are read from verniers at V and V'. Observations can easily be made to half a minute of arc, and much finer work could certainly be done, if it were required. The actual angle of reflection can be measured with an accuracy higher than can be reached in our knowledge of certain other data used in some of the calculations; for example, the actual weights of the atoms.

Crystals are often very imperfect in construction, consisting rather of a conglomerate of smaller crystals in more or less imperfect alignment. It is interesting to observe that the spectrometer may be used in ways which almost completely overcome the evil effects of the imperfections. In the case of a very perfect crystal like the diamond, the slit at A is not used, but B is set very fine; D is wide open. The crystal is slowly turned by a tangential screw attached to the revolving table, and there is no reflection at all outside very narrow limits. The angle of maximum intensity of reflection can easily be determined to a few seconds of arc. But a crystal of rocksalt cannot be treated in this way. It is best to set A and D fairly fine and not to use B at all. On account of certain most fortunate geometrical considerations, a homogeneous pencil of some divergence issuing from A and reflected at various points on the crystal face is brought to a line focus at D, provided that A and D are at equal distances from the crystal (Proc. Roy. Soc., lxxxviii., p. 433). A perfect crystal would reflect such a pencil only along a certain vertical line on the crystal face; but a poor crystal, like rocksalt, at a number of separate points on the face. Even crystals which are scarcely recognisable as such may be treated by this method.

The higher orders of spectra, that is to say, reflections at angles for which n has a large value, three, four, or five, naturally give more accurate values than lower orders, though the intensity diminishes rapidly as n increases. The "resolving power" increases even faster than n, since $d\theta/d\lambda$ is easily seen to be equal to $\tan\theta/\lambda$, which becomes very large as θ approaches the value $\pi/2$. For example, a certain pair of lines emitted by a platinum antikathode are separated by thirty minutes of arc in the first order spectrum reflected by the cleavage face of the diamond, but in the third order spectrum they are two and a half degrees apart.

With a little practice it is quite easy to pick up the reflected X-ray. While the search is being made the slits are opened wide; as soon as the reflection is observed the slits are made narrow, and accurate measurement is then possible. It is a comparatively simple matter to find the angles of reflection of rays of given quality in the various faces or sets of planes of a crystal. The greater difficulty arises in the geometrical interpretation of the results.

THE SEA FISHERIES AND THE WAR.

IT appears possible that the British sea fisheries will suffer from the effects of the war more, perhaps, than most other national industries. Already a large part of the North Sea is closed to trawl fishing, and it may be that before long all this area will become a *mare clausum*. Since we have taken rather more than 60 per cent. of our fish supply from this sea in recent years the loss to the fishing industry is serious. The actual war losses, so far, have been insignificant, but when to these are added the loss to the national food supply of the vessels and men now engaged in mine-sweeping, the disturbance to the industry which must result from the shifting of the fishing fleets to other open waters, and the loss of the Continental markets for cured herrings, the total loss will be sufficiently great. Add to this the incalculable loss which scientific research must bear in the suspension of the international fishery investigations, and we have very much to lay to the blame of German world-politics. The co-ordinated scheme of fishery observations carried on up to last July by the maritime powers of Northern Europe was the laborious result of more than a dozen years' negotiation; probably no one then engaged in it will live to see its resumption.

Upon such industrial and scientific ruin we must endeavour to build anew, and it is fortunate that even before the war the way had been indicated. Scientific research is unlikely to suffer permanently, inasmuch as those engaged in it will turn now to domestic rather than international problems, and that this was desirable, even apart from the war, the recently published report of the Inshore Fisheries Committee indicated. It can scarcely be doubted that the increased exploitation of the lucrative fishing grounds outside the North Sea will compensate, to some extent, for the closure of that area; the enterprise of the English fishing-vessel owners has already been so marked that we need not fear this temporary set-back to the industry. Also the formation of the Fisheries Organisation Society, as the result of the Inshore Committee's report, and with the support and approval of the Board of Agriculture and the Development Commission, was a most fortunate thing, as events have turned out. This body proposes to undertake propagandist work among the inshore fishermen, and generally to take all possible steps to develop to their fullest extent the very considerable natural resources of the shallow seas and foreshores. We cannot doubt that as the result of active and far-seeing measures foreshadowed in the report to which we refer these resources may become a huge national asset in the way of amplifying the food supply and providing productive employment.

Lastly, there is the great East Coast herring fishing and curing industry—one which has already suffered greatly. It is here that propagandist measures are most urgently required, with, we suggest, some State assistance for the holding in this country of the stocks of salted herrings which might yet be obtained in what remains of the present season. Official and semi-official pamphlets and articles already published by the Board of Agriculture and Fisheries and the National Sea Fisheries Protective Association ought to have a wider circulation in order that they may familiarise the people, even well-to-do people, with the enormous supply of excellent and nutritious food in the shape of salted herrings, cod, ling, etc., which is available to the United Kingdom in times of stress. Some education for the British housewife and cook, and some persuasion that the cheapest kinds of fish are little inferior in taste, and not at all in nutritive value, to the dearest kinds are required; and the evening schools and public lectures of the coming months ought to be utilised for these purposes.

It is difficult to estimate the increase of value which industrial exploitation might confer on the raw materials of the inshore fisheries, but one could scarcely err in exaggerating this value. An enormous quantity of shrimps, prawns, and crabs are sold in the fresh (or nearly fresh) condition; by potting or otherwise preserving these raw materials employment would be largely increased, the products would lose nothing of their nutritive value, and would become much more "tasty," while they would be more easily and widely distributed. Enormous quantities of sprats can be caught during the next winter; these are difficult to sell and distribute; in many places they are nearly worthless commercially, while they are nutritious and excellent food. Why should not they be "sardined," thus again enhancing their food value, and conferring employment?

Mussels and cockles can be taken round the shores of England, Wales, and Ireland in very large quantities. For some years past there has been a market for only a small fraction of the shellfish that could be so obtained. This has been the result, almost entirely, of the prejudice that has been set up against these molluscs because exceptionally they have been the means of disseminating epidemic disease. In some cases this fear has been exaggerated, in others it has been well founded, but there can be few cases in regard to which it is not possible to remove all danger by appropriate means. It is quite certain that mussels and cockles can deliberately be laid down and fattened in water which may be polluted by sewage refuse, and then cleansed from ingested micro-organisms by relaying in clean sea-water. Here, again, a national food supply of cheap and nutritious quality can be conserved and amplified by means which also confer unskilled employment upon those who are likely to require it. Also, scarcely any attempt has yet been made to "pot" or preserve in suitable ways these shellfish, but one cannot doubt that efforts in this direction might be highly successful.

There are other fisheries which might conceivably be developed by the fishermen and the manufacturers under appropriate stimuli—the very abundant sea crayfish (or Norway lobster), for instance, a crustacean which is not inferior, either fresh or "potted," to the lobster itself. Herrings might be tinned to a much greater extent than at present. In all these cases the stimulus or suggestion may be made by the official, but it is evident that the hope of developments along these lines lies in the enterprise of the manufacturer. Preserving, curing, and tinning are operations demanding machinery and commercial aptitude and resources. Perhaps the genius of British commerce lies rather more in business organisation, distribution, and the like, than in actual production—at least, such must have been its tendency in times of peace and prosperity. But we have seen that in such a time of national stress as that through which we are passing purely personal commercial interests have been subordinated—the price of fish, for instance, would doubtless have been higher than it is now but for a self-denying ordinance on the part of the distributing trade. National emergency may well be the stimulus to increased development of the sea-fisheries if only the public will back up efforts on the lines we have indicated. J. J.

THE TOTAL SOLAR ECLIPSE EXPEDITION TO HERNÖSAND, SWEDEN.

IT had originally been arranged by the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies that a party consisting of Prof. Fowler, Mr. Curtis, and myself, with Major Hills and Father O'Connor as volunteer observers, should proceed to Kiev in Russia to observe the total solar eclipse of August 21. However, difficulties having arisen with the Russian Government, with regard to the admission of Father O'Connor and myself into the empire, on account of the categorical law excluding Jesuits, it was found necessary to divide the expedition, and ultimately a party consisting of Father O'Connor, Mr. G. J. Gibbs, Mr. E. T. Whitelow, and myself, proceeded to Hernösand in Sweden. Leaving Hull on July 28, and Stockholm on August 2, we arrived at our destination on August 3.

Through the kind offices of Prof. B. Hasselberg, of Stockholm, the head of the Swedish eclipse committee, and the assistance of Father Wulf, of Valkenburg, who with his assistant, Father Rodés, was proceeding to Hernösand, we secured an excellent site for our instruments in a field adjoining the Technical School. Not only so, but the rector of the school, Herr Tham, with extreme kindness and courtesy, placed the whole establishment, with well-equipped laboratories, dark room, mechanical and carpenters' shops, practically at the entire disposal of the astronomers of the two parties.

Father Wulf erected his apparatus in a large lecture room facing due south, and Father Rodés had a fine coronagraph mounted equatorially in an adjoining portion of the grounds. Father Wulf made successful observations of the exact duration of totality, and the times of second and third contacts, by means of an Elster and Geitel potassium photo-electric cell. This formed one arm of a Wheatstone bridge and was balanced by a resistance of several megohms, the resistance of the other two arms being furnished by those of the battery of many cells which supplied the current to the electrometer. The difference of potential, due to the ionisation of the helium and argon contained in the cell, with a corresponding alteration in its resistance, caused by the variation in the intensity of the light falling on the face of the cell, affected a thin wire, 1/500-mm. thick, in the special electrometer invented by Father Wulf, which was displaced laterally. These displacements were recorded on a suitable drum with ample scale on the photographic film, which was clock-driven. A thin wire attached to a pendulum beating seconds passing in front of a source of artificial light gave the time scale.

Our own equipment (Fig. 1) consisted of three coronagraphs of 20 ft., 30 in., and 12 in. focal lengths, and a large spectrograph of the Littrow form. The three coronagraphs were mounted in echelon in front of a 16-in. cœlostat, being placed in the azimuth of sunrise. The same cœlostat also supplied a beam of light to a 3-in. Cooke lens, which projected an image of the sun 4¼ in. in diameter on a graduated screen of ground glass, so as to obtain the angles subtended by the cusps at the sun's centre 10 minutes, 5 minutes, and 10 seconds before totality. This instrument was mounted above the 20-ft. coronagraph, so that Father O'Connor, operating the coronagraph, was also able to give the signals at the stated times before totality. The 30-in. and 12-in. coronagraphs were under the charge of Mr. Whitelow, who also made exposures before and after totality with a Zeiss single Protar lens of 14-in. focus, working at f/16. This camera was mounted on a tripod with wedge head cut to the latitude of Hernösand. He obtained photographs of the moon projected on the corona 30 seconds and 1 minute after totality. The optical parts of the Littrow spectrograph consisted of a single dense glass prism, 7-in. edge and angle 40°,

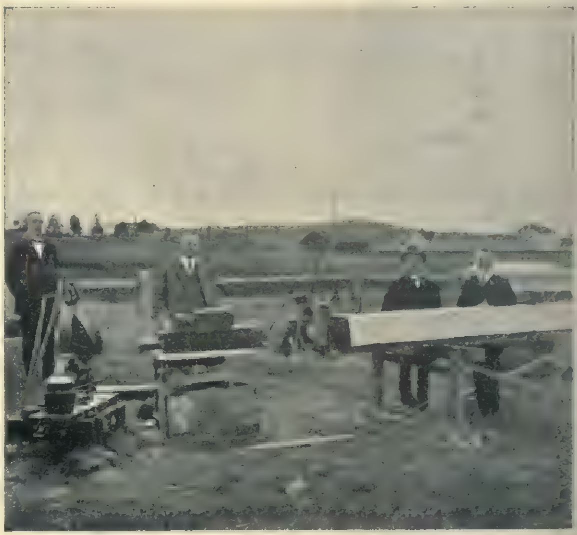


FIG. 1.—The eclipse instruments, Hernösand.

a 6-in. lens of 98 in. focal length, and a 6½-in. flat mirror. A Grub cœlostat of 8-in. diameter supplied a beam of light to a 5-in. Alvan Clarke lens of 7 ft. focal length, which formed the sun's image on the slit.

With the assistance of the town electrician, Herr Helenius, leads were run from the electrical plant in the technical school to operate an arc-lamp with iron poles, the pressure being 110 volts and the current 12 amperes. An auxiliary lens and a diagonal prism, which could be pushed backwards and forwards as required, formed the image of the arc on the slit. The slit could be covered with a plate of zinc having a horizontal aperture 1/10-in. in width, so that the comparison spectrum could be placed over the position occupied by the image of the dark moon. Owing to the skill and energy of Mr. Gibbs, the engineer to the party, the instruments were all erected, the cases being utilised as bases, and adjusted, by Monday, August 17, on which day drills were commenced. We were assisted by students of the technical school under the direction of Mr. Askling, the master of mechanical science. An eclipse clock, designed by Mr. Gibbs, was also erected, a large hand circulating round the dial once in 129 seconds, the computed duration of totality. Its face was lit up by an electric lamp.

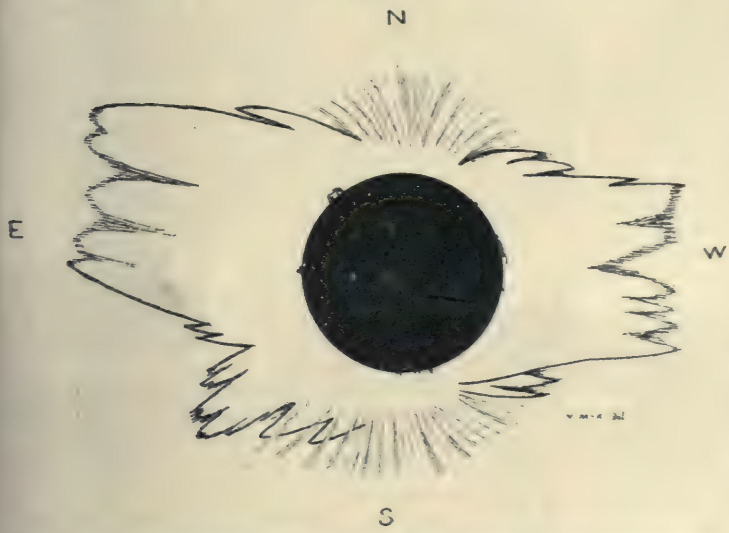


Fig. 2.—Main features of the Solar Corona of 1914, August 21, roughly outlined from photographs taken with the 20-ft. coronagraph at Hernösand.

The purity of the atmosphere at Hernösand was remarkable, but there was a very considerable amount of cloud on every day, except one, during the days preceding the date of the eclipse. The barometer was high with a persistent north-west wind, accompanied by a variety of types of weather. On the evening, however, of August 20, the wind changed to the south-east, and a beautiful night heralded the perfect weather conditions for the eclipse. The programme settled for me by the Joint Permanent Eclipse Committee was to obtain large scale photographs of the solar corona to show detail, and smaller scale pictures to show the extension. With the spectrograph the coronal spectrum was to be photographed, principally in the red and yellow regions, and if possible a comparison spectrum of the iron-arc was to be placed on the plate.

About half-past eleven on the morning of the eclipse a goodly number of spectators, dressed in their best clothes, assembled in the field near the site of the instruments, and watched the partial phases through dark glasses. In contrast to the demeanour of the spectators in the eclipse expedition to Vinaroz in Spain in August, 1905, they were quite undemonstrative, even when the magnificent sight of the corona in a perfectly dark sky was presented to their gaze. For certainly it was a magnificent spectacle, enhanced by the appearance of the planet Mercury brilliantly shining to the north-west limb of the sun, and Venus near the south-east horizon. To the naked eye the most striking features of the corona were a long fish-tail streamer on the west limb of the sun, and a spreading mass of streamers on the east limb, the salient phenomena being a streamer on the north-east, another shorter streamer south-east, and a long horizontal streamer, less luminous than the other two, placed equatorially. The prominences were not visible to the naked eye; they were seen projected on the slit, and a very fine arched prominence is shown in the north-east quadrant in the photographs. Five large scale photographs were secured with the 20-ft. coronagraph, with exposures of 4, 10, 25, 7, 3 seconds respectively. These show a great amount of detail, including beautiful sheafs of polar rays, prominences, and several crossing and interlacing streamers. The main features are shown in the accompanying outline drawing (Fig. 2), made from some of the negatives by Mr. W. McKeon. With the 30-in. Abney coronagraph, used in so many former eclipses, four photographs were secured, with exposures of 10, 50, 15, and 5 seconds, on plates bathed by Mr. Crowther, of Carlisle, so as to be not solarisable by over-exposure. These show the extension of the corona for fully two solar diameters. With the 12-in. coronagraph, working at $f/3{\cdot}5$, a single exposure was made for 95 seconds, on a Paget "Hydro" non-solarisable plate. This is a beautiful small scale picture, showing, probably, the full extension of the streamers.

With the spectrograph, while I made the exposures, Mr. Gibbs placed the sun's image correctly on the slit, and also took charge of the cœlostat. Several exposures were made at intervals of a few seconds on the tip of the cusps, seven minutes before and five minutes after totality. These mere lines of spectral light have so far not received adequate study. The comparison iron spectrum is on each plate, which contains, besides, six exposures on the cusp tip. The spectrum of the corona shows very faint continuous spectra between λ4800 and λ6700, with several faint lines on each side of the comparison iron spectrum, and others further removed obviously belonging to the portions of the streamers intersected by the slit. The exposure of the plate was about 95 seconds, and that of the arc spectrum 4 seconds at mid-eclipse. The slit was placed just within the dark limb of the moon on the advancing side. A batch of freshly bathed Panchromatic B plates was kindly forwarded to Hernösand by Messrs. Wratten and Wainwright.

On account of the war the programme for our homecoming had to be considerably modified. The plates were at once developed, and the instruments speedily dismounted, so that we might catch the first possible steamer from Hernösand to Stockholm. From Stockholm we came across land *viâ* Christiania to Bergen, whence we sailed to Newcastle. We had already crossed two Swedish mine fields under the escort of armed vessels, and our passage of the North Sea was no less adventurous and exciting. We were stopped by a British cruiser and warned of the presence of floating mines laid by the Germans directly in our intended course. The lifeboats were got ready, and the course was changed for one to the north of Scotland. A second cruiser pursued us, and, overtaking us, warned us of the danger ahead. Accordingly we came right down the Scotch and English coasts, and finally were convoyed into the mouth of the Tyne by three torpedo-boats.

A. L. CORTIE.

THE BRITISH ASSOCIATION IN QUEENSLAND.

Brisbane, September 4.

THE final session of the Australian meeting of the British Association for the Advancement of Science was held in Brisbane on August 27—September 1. It had been arranged that of the 320 visiting members of the Association, a party of one hundred should visit New Zealand after the close of the Sydney Session, and that the remainder should visit Brisbane, where the final official business would be transacted. Unfortunately the state of war in which Australasia in common with the rest of the Empire is involved, interfered somewhat with this arrangement. The cancellation of the New Zealand meeting caused a number of those, who would otherwise have gone to the Dominion, to express a desire to visit Brisbane instead. At the same time the utilisation of the R.M.S. *Orvieto* as a transport caused a number of people who had intended returning to England in her to shorten their visit to Australia.

As a consequence of these changes in *personnel* of the party which came to Brisbane the local

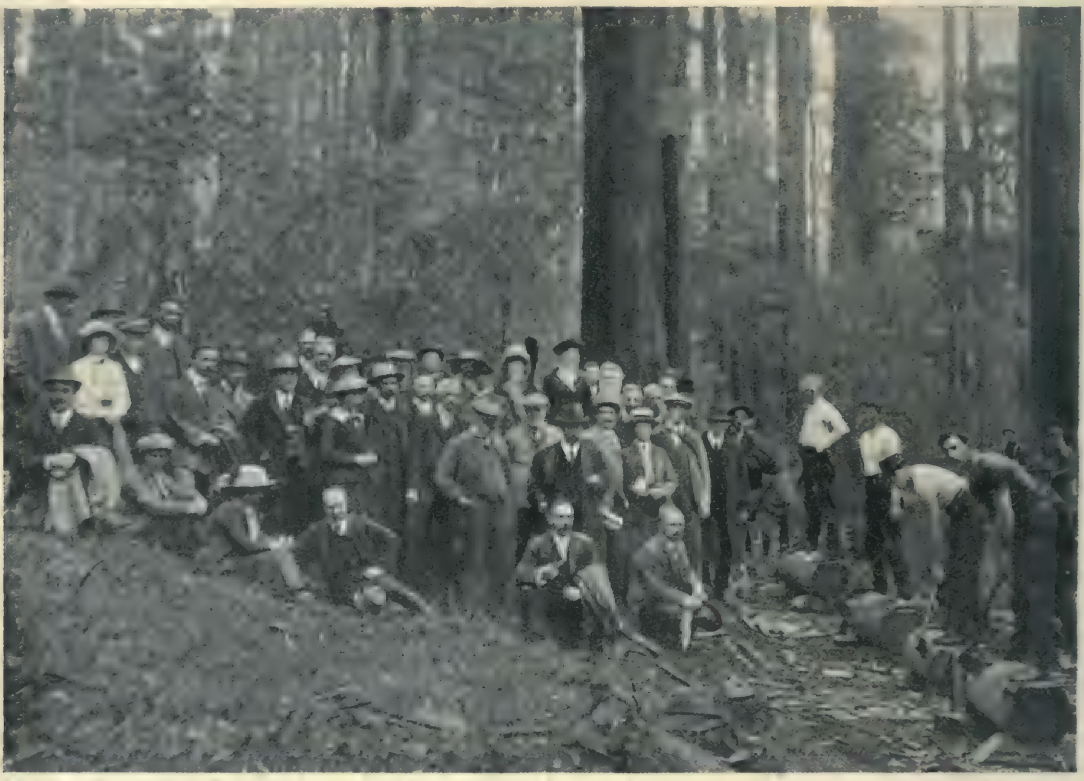


Photo.] [*Topical Press Agency.*

FIG. 1.—An excursion party of the British Association at a wood-chopping contest in the Australian bush.

arrangements suffered disorganisation to such an extent that the plans which had been formed had to be modified greatly, and fresh arrangements made in the four days immediately preceding the meeting.

The Brisbane party left Sydney on Wednesday, August 26, in two special sleeping trains. The visitors arrived at Wallangarra on the Queensland border in time for breakfast, at which and also at lunch they were the guests of the Queensland Government. At Wallangarra a change of gauge occurs, the New South Wales gauge of 4 ft. 8½ in. being left behind, and the narrow gauge of 3 ft. 6 in., which is common to all the Queensland railways, being reached. The party travelled from Wallangarra in two special trains, arriving at Toowoomba in time for luncheon and reaching Brisbane about 6 p.m.

The arrangements which had been made for the conveyance of the visitors to the homes of their guests worked very satisfactorily, and within eight minutes of the arrival of the trains the last of the visitors had left the station.

The reception room and post office were situated at the temporary university building, but unfortunately it was not possible to arrange for the lectures and addresses to be delivered there on account of the absence of any hall or lecture-room large enough to accommodate the audiences which were anticipated.

Two addresses were delivered on Friday morning in the Albert Hall. The first, which was officially described as the second part of the presidential address in Section M (Agriculture), was given by Mr. A. D. Hall, who chose as his subject "Tropical Agriculture." The hall was well filled with a large and appreciative audience; the local members were particularly interested in the subject, and it is hoped that the address will prove helpful in many ways.

It had been originally planned that the second address should be the second part of the presidential address in Section I (Physiology) on the subject of "Tropical Diseases," and on account of the peculiar local and climatic interest of the subject chosen much disappointment was felt in Brisbane at its unavoidable abandonment. In place of this Prof. E. W. Brown, of Yale, delivered an address on cosmical physics.

Two public lectures or discourses were arranged for Friday evening. Prof. Armstrong lectured to an interested audience in the Centennial Hall on the "Materials of Life." In his lecture he traced the building up of the simple compounds of carbon, hydrogen, oxygen, and nitrogen into the complicated compounds which are synthesised in the plant organism; also the breaking down of these under enzyme and other action during the process of digestion and the building up again from these relatively simple substances of the highly complicated products which are prepared in the animal organism. A vote of thanks was proposed by Prof. Steele, of Brisbane, and the subject was discussed by Prof. Bateson, who occupied the chair. The second lecture was held in the Albert Hall on the same evening. Sir Oliver Lodge occupied the chair, and Prof. Howe gave an interesting discourse on wireless telegraphy.

The meeting closed on Monday evening, when Sir Edward Schäfer gave a discourse on the subject "Australia and the British Association." At the conclusion of the lecture Sir Arthur Morgan, Lieutenant Governor of the State of Queensland, proposed a vote of thanks to the lecturer.

A citizens' lecture on decorative art in Papua was delivered by Dr. Haddon to a large audience in the Exhibition building, the Mayor of Brisbane, Alderman C. Jenkinson, occupying the chair. There were two garden parties given in honour of the visitors, one on Friday afternoon in Bowen Park by the Mayor of Brisbane, and another on Monday afternoon in the university grounds by the Government of Queensland, the Lieutenant Governor receiving the guests on behalf of the Government.

Photo.] [*Topical Press Agency.*

FIG. 2.—An excursion party of the British Association in the Australian bush.

The Senate of the University entertained the general officers of the Association, the presidents and ex-presidents of sections, and the foreign visitors at luncheon on Friday, August 28. The vice-chancellor, Mr. R. H. Roe, was in the chair, and proposed the health of the guests. This was replied to by the president, Prof. Bateson, in a speech extremely inspiring and helpful to our young University.

The week-end was devoted to excursions, and amongst other places visited were the mines at Gympie and at Mount Morgan, the sugar and fruit-growing districts of Nambour and Cleveland, and the Prickly Pear infested country of the middle West, and the Prickly Pear experimental station at Dulacca. The officer in charge of this station is Dr. Jean White, who at present has more than 2000 experimental plots under investigation, and the object of whose work is to ascertain the best means of exterminating the pest.

After the close of the Brisbane session, the party separated, some returning to Europe by way of America, others through Java and India, and a large number of the party travelled by the mail route through the Suez Canal.

[One of the week-end excursions during the visit of the British Association to Melbourne, referred to in an article in our issue of October 8, was to the Warburton district, where the giant ferns and gum-trees, rising in some cases to a height of about three hundred feet, gave the visitors impressive views of Australian bush scenery. The two photographs here reproduced show the party watching a wood-chopping contest, and in one of the gullies of the forest rich in objects of botanical interest.]

NOTES.

The Harveian oration on advances in knowledge regarding the circulation and attributes of the blood since Harvey's time, was delivered at the Royal College of Physicians on Monday, October 19, by Sir Douglas Powell. After the oration Sir Ronald Ross was presented with the Bissett Hawkins Memorial Medal for distinguished services in the advancement of sanitary science and public health.

The question of the continuance of meetings of scientific societies during the war, raised by Dr. W. T. Calman in a letter which appears elsewhere in this issue, is one which each society must decide for itself after taking into consideration the papers likely to be forthcoming, and the number of fellows or members likely to attend meetings at which they are presented. It is to be hoped, however, that if meetings go on as hitherto, any German or Austrian members of the societies will absent themselves for the time being, as objection might be taken to their presence under existing conditions.

Many leading men of science in the British Isles, as well as distinguished representatives of other branches of learning, have signed a statement which has just been issued in reply to manifestoes published by various university professors in Germany. The statement refers to the policy of national aggrandisement based on the threat of war advocated by von Treitschke, von Bülow, von Bernhardi, and strongly supported by public opinion in Germany; and it summarises the diplomatic papers in which the events are described that forced Great Britain into the present war if she wished to preserve an honourable position among nations. The concluding paragraph is as follows:—"The German professors appear to think that Germany has in this matter some considerable body of sympathisers in the universities of Great Britain. They are gravely mistaken. Never within our lifetime has this country been so united on any great political issue. We ourselves have a real and deep admiration for German scholarship and science. We have many ties with Germany, ties of comradeship, of respect, and of affection. We grieve profoundly that, under the baleful influence of a military system and its lawless dreams of conquest, she whom we once honoured now stands revealed as the common enemy of Europe and of all peoples which respect the Law of Nations. We must carry on the war on which we have entered. For us, as for Belgium, it is a war of defence, waged for liberty and peace."

The Royal Photographic Society has just opened to the public a house exhibition of photographs by Mr. Lewis Balfour, "Bird Life on the Bass Rock." There are upwards of one hundred of these pictures showing the various sea birds and incidents in their lives. The public will be admitted free, daily from 11 a.m. to 5 p.m., until November 28.

The second Thomas Hawksley lecture will be delivered in the meeting hall of the Institution of Mechanical Engineers on Friday evening, October 30, by Mr. W. B. Bryan, the subject being "Pumping and other Machinery for Waterworks and Drainage." The Thomas Hawksley fund was founded by Mr. Charles Hawksley to perpetuate the memory of his father who was president of the Institution of Civil Engineers in 1871 and 1872, and president of the Institution of Mechanical Engineers in 1876 and 1877. The income of the fund is devoted to the maintenance of a lecture and to the award by the council of the Institution of Mechanical Engineers annually a "Thomas Hawksley" gold medal, with or without a premium, in money, books, or otherwise for the best original paper read at a general meeting of the institution or printed in its proceedings.

Prof. David Todd, who passed through London a few days ago on his return to the United States from Russia, where he observed the total solar eclipse of August 21, as will be described in a later issue, brought with him a very successful kinematograph film of the eclipse, and by the courtesy of Messrs. Pathé Frères it was projected upon the screen of their theatre in Charing Cross Road. The film reproduced the solar corona with the narrow crescents before and after it with great fidelity. It was taken by Dr. N. V. E. Nordenmark, of Stockholm, at Sollefteå, Sweden, latitude N. 63° 12′, longitude 45′ west of Stockholm, where the sky was absolutely free from cloud. The lens was a 50 mm. Zeiss of 305 mm. focus, and the exposures were about six to the second. In all there are more than seven hundred excellent pictures of the corona, which is well seen even into the partial phase.

The death of Dr. Anthony Traill, provost of Trinity College, Dublin (writes E. P. C.), removes a forceful personality from Irish life. Of striking all-round ability, never brilliant, but possessing an indefatigable power of work, he outdistanced many of his colleagues who, from the academic point of view, were more highly endowed. Taking his LL.D. at twenty-six, he obtained fellowship next year, 1865, and shortly afterwards he entered the medical school, taking his M.D. in 1874. In 1899 he was co-opted a senior fellow, and was appointed provost in 1904, *vice* Salmon. If he was wanting in some qualities usually looked for in a provost, he possessed, and in a high degree, others not so often found in academic men, and thus he was able to bring the college safely through the extraordinarily critical times of the Parliamentary settlement of the Irish University question, and the, in some ways more delicate one, of internal reform. For this reason, and the untiring energy with which he strove to widen its activities, he deserves the hearty gratitude of the college, and must be ranked as one of its most efficient provosts. Of the man himself, it is difficult to give an idea in a few lines. His interests were exceedingly wide. As an athlete, an alpine climber, a good cricketer, a rifle shot, as a college fellow and tutor, as a member of public boards and commissions, as a financial adviser to the Church of Ireland, he always acted up to the maxim, "Whatsoever thy hand findeth to do, do it with thy might." Up to his seventy-fourth year he was remarkable for bodily vigour, even then shooting over his bogs for an entire day without a sign of fatigue; and what must be regarded as his premature death at seventy-six was due to his almost contemptuous disregard of painful symptoms to which far younger men would have yielded. He was seen at his best as a most kindly and entertaining host in the family home at Ballylough.

Owing to the absorbing attention given by our newspaper Press to the war, we receive but the scantiest notices of important earthquakes, even when they occur in our own Colonies. From the *Morning Post* for October 15, we learn that, at 2.15 a.m. on the day before, an earthquake was felt all over the colony of Jamaica, strong enough to awaken the inhabitants, but not to cause any damage to buildings.

On October 17, at about 8 a.m., the whole of Greece was shaken by violent earthquake shocks, the first of which lasted twenty seconds. The centre was apparently near Thebes, where a number of houses fell, especially in the villages of Cappareni and Pirri, which were partially destroyed. Atalante and Chalcis were also seriously injured, and all the railway stations on the Larissa line were damaged. The shocks were also felt in the Peloponnesus, the Cyclades, Euboea, and the Ionian Islands. Several houses at Athens and the Piraeus were cracked, but none of the ancient monuments suffered. A few persons were injured, but, so far as known, no lives were lost. Though much less severe than the earthquakes of April 20 and 27, 1894, the recent shock seems to have originated in the same region, and probably in the same great fault. This fault was traced by M. Papavasiliou for a distance of thirty-three miles, passing through Atalante, in a direction parallel to the adjacent Gulf of Euboea. The throw was generally small, though in places it amounted to as much as 4 or 5 ft. (see Nature, vol. l., p. 607).

The *Philippine Journal of Science* for April last supplies an interesting account by Mr. E. B. Christie of the pottery industry at San Nicolas, in the Ilocos Norte province. A modified form of the potter's wheel is used, the clay being shaped into a short, thick cylinder, and laid on a board which rests upon a second board, but not connected with it by a bearing-pin. From time to time the woman worker gives the upper board a turn with one hand while she works the clay with the other. At first she uses only her fingers to shape the vessel. Later on she holds a smooth stone against the inner surface of the vessel with her left hand while with the other she works a paddle to form the outer surface. With the paddle she beats the clay, causing it to spread. When the vessel is complete, she smooths the outside with a shell and smears it with red earth mixed with water in order to produce a uniform colour. If she does not do this, the clay assumes a weak, irregular colour when it is fired. If she desires to blacken the pot, it is, while still very hot, covered with rice bran. This becomes imperfectly consumed, and leaves a black deposit on the clay. The industry is purely domestic, but it is of some economical importance.

In the October number of *Man* Dr. H. Basedow furnishes an obituary notice of Mary Seymour, the last relic of the lost Tasmanian race. Born in 1833, she died in 1913, her mother being a full-blooded Tasmanian aboriginal, who married a whaler named Nat Thomas. On her marriage to Joseph Seymour, Mary for the first time learned a little English, and she claimed to be the first woman born on Kangaroo Island. She used to give graphic accounts of her experiences in the pioneering days of South Australia. She was of short but robust stature, and her features indicated a keen intellect combined with a determined will. Seen in profile, the deep notch below the glabella at the root of the nasal bones betrayed a Tasmanoid inheritance, described by Dr. Garson (Journal Anthropological Institute, vol. xxvii., plate 27) as one of the characteristics of the race. The hair was silken, white, and wavy, the eyebrows bushy. Her lips and skin were remarkably free from hair, and her skin was of a dark bronze-brown and wrinkled with age. The lower jaw was well developed, and had a big loose flap of skin attached to it that produced a very noticeable double-chin. The keen, small eyes lay deep within their sockets; their colour was a greyish-brown. It is interesting to compare the photographs accompanying the article with those published by Mr. H. Ling Roth in his classical memoir descriptive of this interesting race.

The preventive treatment of fowl cholera is dealt with by Mr. Philip B. Hadley in Bulletin 159, Agricultural Experiment Station of the Rhode Island State College, U.S.A. Various avirulent cultures of the fowl cholera micro-organism were found to be protective to rabbits against certain virulent strains of the organism, either singly or in combination. Attempts are now being made to produce a corresponding protection among poultry, for fowl cholera is a disease which frequently causes considerable loss to the poultry farmer.

IN the report of the Leyden Museum of Natural History for the year ending September 1, 1914, Dr. E. D. Van Oort, the director, pays a well-deserved tribute to the work of his predecessor, the late Dr. Jentink. The additions to the collection were numerous, and the number of visitors during the year 3134.

RECRUITS of the Transport Corps are receiving instruction from their officers in the north hall of the British Museum (Natural History) on the external characters and osteology of the horse. For this purpose a mounted skin and a skeleton of the horse have been removed from their cases and placed on the floor of the hall, from which the general public are excluded during the periods of instruction. We understand that the officers of the Veterinary Department, aided by the Transport Corps, have succeeded in rendering a large number of wounded or otherwise injured horses at the front fit for further service; such horses include many taken from the Germans.

IN an editorial article on eugenics and war in the October issue of the *Eugenics Review*, it is pointed out that "the British Empire, by reason of maintaining her army on a voluntary basis, must inevitably suffer racially more than other nations. The battle death-rate must strike her unevenly and reduce the number of her males amongst the class from whom it is most desirable that she should produce the stock of the future. In the countries with universal compulsory service, the reduction in effective males will be spread over the entire population; good and bad will alike be reduced. In this country the types which are physically and mentally superior will volunteer for active service. . . . The sample of those killed will not be the average of the race, but the best type of the race. . . . Although the system may give victory and national prestige, the racial effect must be injurious."

THE contents of Nos. 3 and 4 (issued in a single cover) of vol. xxxvi. of *Notes from the Leyden Museum* consist exclusively of papers on invertebrates, the longest of which is a continuation of Dr. R. Van Eecke's "Fauna Simalurensis," dealing with Indo-Australian Lepidoptera. Dr. J. H. Vernhout also contributes a further instalment of the results of his study of the land and fresh-water molluscs of the Dutch American colonies, discussing in this instance those of Curaçao. It would be natural to expect that the land-snails of the Curaçao group of islands should exhibit a close affinity with those of Venezuela; as a matter of fact, this is far from being the case, only seven out of twenty-five species recorded from the three islands being common to the mainland. Nor is this all, for many even of the genera are quite unknown on the South American continent, but are more nearly related to or identical with Central American and Jamaican types.

IN these columns (October 2, 1913) reference was made to the regional survey undertaken by the Croydon Natural History and Scientific Society. In the 1913–14 volume of the society's Proceedings and Transactions, which we have received, an account of the general progress of this survey is given in the form of a report by the survey committee. The scheme has aroused much interest, both within and outside the society, has caused the revival of the photographic section, and increased activity in the botanical, zoological, and archæological sections, and has brought about closer co-operation between all the sections of the society. Mr. C. C. Fagg, secretary of the regional survey committee, contributes an introductory paper on the mineral and agricultural industries of the survey area, dealing with these from the geographical point of view, with plates and a geological (drift) map of the Croydon area.

WE have received the report of the Botanical Survey of India for the year 1913–14, in which the officiating director of the survey, Mr. C. C. Calder, summarises the extensive and valuable work done during this period. Under the heading of systematic work, references are made to the results, published in the records of the survey and in other journals, of the field investigations made by members of the survey staff and others, and it is interesting to note that in many cases these results include not only lists of species collected, but studies of the vegetation in various aspects, the distribution of the species being correlated with the adaptations of the plants to their environment and their aggregation into plant communities. This ecological side of field work in botany has not hitherto figured largely in Indian botanical publications, but as the systematic survey proceeds it will doubtless be accompanied by further and more intensive distributional and ecological study. The chemical part of the work hitherto undertaken at the Indian Museum, Calcutta, has now been transferred to other departments, while the newly appointed economic botanist to the survey, Dr. H. G. Carter, has begun the collection of materials necessary for the compilation of the work on Indian plants of economic importance urged by the Royal Society some years ago. There is also in active preparation an index to all species of Indian plants not included in Hooker's "Flora of India"; this index already contains nearly 900 species, and will be published as a single number of the records of the survey.

THE report for the past year of the New Zealand Department of Scenery Preservation states that 3000 acres were reserved, bringing the total area of scenic reserves in the Dominion to 214,000 acres, comprised in 363 different reserves. It is pointed out that the great bulk of this land is unsuitable for settlement, while it assists to conserve water, protect soil, and prevent denudation. Private residents have shown remarkable munificence in presenting areas to the

Government. The Scenery Preservation Act of 1903, consolidated in the Act of 1908, provided a total sum of 100,000*l.* Each year a portion of this is authorised for expenditure; a balance now remains of 27,136*l.* It is curious that the native Maoris are the only section of the population that does not approve of the movement. Among details of interest the following may be cited. Deer are extremely detrimental to forest. The lakes of New Zealand have been formed by the erosive action of huge bodies of ice or by volcanic action; but Waikaremoana was formed by an immense fault in the stratification of the country. The greater part of forest is beech, with its two varieties of black and red (*Nothofagus solanderi* and *fusca*). Native flowers and birds are well looked after in these reserves, and the National Society for the Protection and Preservation of New Zealand Forests and Bird Life has just been formed. "Each member of the society should consider himself an unofficial ranger." It is noteworthy that most of these reserves coincide with health resorts and sporting centres. Perhaps the most beautiful of them all is Day's Bay, only forty minutes from Wellington, and a favourite excursion. This bit of forest is as it was 1000 years ago. Another gem is the reserve on the Waganui river, which is "the finest sight of its kind in the whole world." "It is no compliment," said a Russian traveller who had seen the great rivers of the world, "to call the Wanganui 'the New Zealand Rhine.'"

IN Publication No. 4 of the Meteorological Institute of Chile Dr. W. Knoche gives a very interesting discussion of the hourly observations specially made at Mataveri, Easter Island, for one year ended April, 1912. From a meteorological point of view the position of the island is important for the study of atmospherical circulation; it lies in the south-east Pacific Ocean (approximately 27° 10′ S., 109° 26′ W.) in one of the permanent areas of high barometric pressure, and within the limit of the trade-winds, especially in summer. Notwithstanding the uniformity of the climate, one year is naturally too short a period to deal with satisfactorily, and we are glad to see that Dr. Knoche has been able to make arrangements for observations to be continued, although on a smaller scale. The mean barometric pressure (M.S.L.) was: January, 30·08 in., July, 30·06 in., year, 30·06 in.; but conditions are said to differ considerably in different years, probably owing to the shifting of large masses of air in the high-pressure area. Rainfall during the summer half-year amounted to 22·2 in., and in other months to 27·9 in. The mean of the hottest month was 74·8° in February, and of the coldest 64·2° in October. The absolute extremes were 87·8° in February, and 51·1° in July. An unpleasant feature of the island is that it is infested by large swarms of mosquitoes. The volume is well illustrated by curves and diagrams.

THE Journal of the Washington Academy of Sciences for September 19 contains a short account of the results obtained by Messrs. G. K. Burgess and J. N. Kellberg, of the Bureau of Standards, during an accurate investigation of the changes of the electrical resistance of pure iron wire up to a temperature of 1000° C. A platinum and an iron wire of about an ohm resistance were wound on porcelain insulators in an evacuated quartz tube, heated in an electric furnace. The resistance of each wire was determined by the bridge method with an accuracy of 0·00001 ohm, during the slow heating and cooling of the furnace. That of the platinum wire served to determine the temperature of the iron wire. The resistance of pure iron on heating was found to increase at a rate which itself increases up to 757° C., the temperature at which the iron ceases to be ferromagnetic. Above that temperature the rate of increase again decreases, so that at 895° C. the resistance reaches a maximum, and at 906° C. a minimum beyond which it appears to increase regularly. On cooling the minimum occurs at 880° C., the maximum at 870° C., and the change in the rate of decrease again at 757° C. The authors attribute the nonreversible change at the higher temperatures to recrystallisation, but they have not been able to detect any crystalline change at the 757° C. point.

THE forthcoming books of the *Cambridge University Press* include:—A Theory of Time and Space, by A. A. Robb; The Surface of the Earth: Elementary, Physical, and Economic Geography, by H. Pickles; The House-Fly, by Dr. C. Gordon Hewitt (in the Cambridge Zoological Series); A Book of Simple Gardening, by D. Lowe; and (for the University of Chicago Press) Water Reptiles of the Past and Present, by S. W. Williston; and Assyrian and Babylonian Letters, edited by R. F. Harper, vol. xiv.; and *Mr. John Murray* announces:—A Hunter-Naturalist in the Brazilian Wilderness, by Theodore Roosevelt, illustrated; Emma Darwin: a Century of Family Letters, 1792–1896, edited by H. Litchfield, two vols., illustrated (the second volume of the work will contain many unpublished letters of Charles Darwin, supplementing his biography by giving some idea of the more intimate side of his life); Concerning Animals and other Matters, by E. H. Aitken ("EHA"), with a Memoir of the author by Surgeon-General W. B. Bannerman, illustrated; A History of the Gold Coast and Ashanti, from the Earliest Times to the Beginning of the Twentieth Century, by W. W. Claridge, two vols.; a new and enlarged edition of The Rudiments of Practical Mathematics, by A. Consterdine and A. Barnes.

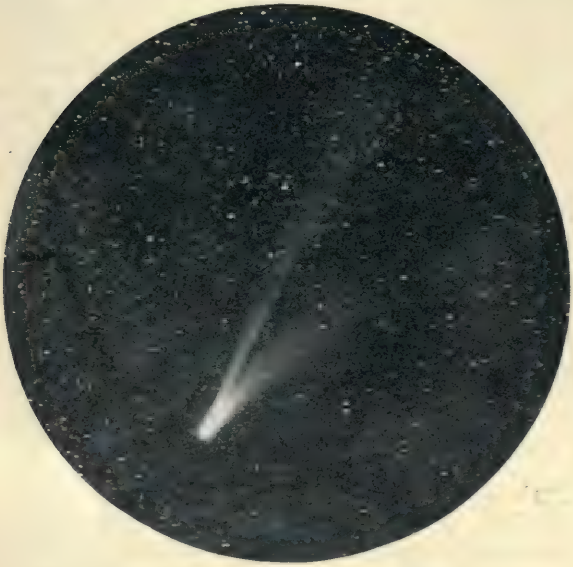
MANY rare and valuable books and papers relating to mathematical, physical, and natural sciences, and to technology, are included in a catalogue, "Bibliotheca Chemico-Mathematica," part x., just received from Messrs. Henry Sotheran and Co., 140 Strand, W.C., and 43 Piccadilly, W. The catalogue contains descriptive notes upon a large number of the books and authors, and should be of assistance to bibliophiles in search of important scientific works. We notice particularly books by, and on, Pasteur, Paracelsus, Priestley, Réaumur, Regiomontanus, Respighi, and many other authors, both ancient and modern.

OUR ASTRONOMICAL COLUMN.

COMET 1913*f* (DELAVAN).—Delavan's comet is now a more prominent object in the evening sky, and can be picked up by anybody without an ephemeris: it has a tail of considerable length and brightness. The comet is rapidly moving in declination covering about 3° in four days. It is also visible as a morning object. The comet passes perihelion on October 26, and in the meantime should become brighter. The following is a continuation of Prof. Biesbroeck's ephemeris up to the end of the present month:—

		R.A. h.	m.	s.		Dec. °	′
Oct. 22	...	13	56	0	...	+29	33
26	...	14	12	0	...	26	27
30	...	14	26	36	...	23	25

We are indebted to Prof. David Todd for a print, here reproduced, of a photograph of the comet taken last month by Dr. Karl Bohlin at the Stockholm Observatory.



Delavan's Comet, September, 1914. Photographed at Stockholm Observatory. Exposure, one hour.

ENCKE'S COMET.—The October number of the *Observatory* publishes the elements and ephemeris of Encke's comet as computed by M. L. Matkewitsch, of Pulkova. The latter for the present month are as follows:—

		R.A. h.	m.	s.		Dec. °	s.
Oct. 20	...	8	29	44	...	+61	37
22	...	9	26	3	...	60	28
24	...	10	20	21	...	57	42
26	...	11	7	51	...	53	27
28	...	11	46	43	...	48	7
30	...	12	17	33	...	+42	10

The corrections to this ephemeris on about October 27 are given as R.A. +8s., declination −6′. It is stated that the comet will be nearest the earth on October 27, and is generally a fairly conspicuous object when perihelion occurs in winter. It has sometimes been glimpsed with the naked eye.

THE RECENT ECLIPSE EXPEDITIONS.—Further news is to hand regarding the experiences of some of the recent eclipse expeditions (the *Observatory*, October). The party from the Solar Physics Observatory, Cambridge, seems to have had particularly bad luck, for not only did a thick detached cloud completely hide the whole of the total phase, but even the telegrams announcing the complete failure of the observations never reached home. Prof. Newall, who writes this account, draws the moral of "the importance of spreading the camps of observing parties even in the restricted area chosen for a station of observation." Prof. Perrine set up his instruments in the same camp as the Cambridge party, and suffered a similar fate. While this camp was about four kilometres from Theodosia, on a site one kilometre nearer Theodosia, MM. Beljawsky and Neujmin obtained observations for about 30 seconds. At Theodosia the eclipse was seen in blue sky between patches of cloud, and observations were made during the whole total phase. Among the observers there were Signor Ricco, Count de la Pluvinel, Dr. Donitch, Prof. Sternberg (Moscow), M. Crétien (Nice), and M. Ascarza (Madrid). Dr. Backlund's expedition to Riga met with success, and Prof. Newall refers to "the beautiful photographs of the corona" secured by M. Kostinsky, who was of that party. Prof. Campbell and his party, who observed at Kiev, had adverse weather conditions.

An interesting account of the Greenwich Eclipse Expedition is given by Mr. H. S. Jones, one of the official observers. This party, at Minsk (Russia), had a narrow escape, for "when totality commenced a long cloud was approaching the sun, but fortunately did not reach it until the last second of totality." The whole programme was thus carried out. The corona he describes as "comparatively bright, and of a steely-blue whiteness, with no trace of yellow—it was of the intermediate type, with four streamers, resembling somewhat the 1898 corona."

SOCIETÀ DEGLI SPETTROSCOPISTI ITALIANI.—The July and August numbers of the *Memorie della Società degli Spettroscopisti Italiani* contain numerous contributions of interest on various subjects. In the July number the variable R. Leporis is dealt with by E. Padova, who publishes some new observations and a calculation of the period, which he gives as 438·93 days. This is Hind's famous crimson star, which in 1845 was described by him as "of the most intense crimson, resembling a blood-drop on the background of the sky. . . ." Some new observations and a discussion of them relating to the variable ST Ursæ Majoris are communicated by G. Silva. A preliminary note by E. Paci describes the observations made for the determination of the latitude of the centre of the cupola of the Etna Observatory. The observations were secured during 1913 by the Horrebow-Talcott method, and the value derived was +37° 44′ 8·392″. The last-mentioned author contributes two papers to the August issue, the first dealing with a study of the Ertel meridian circle of the Catania Observatory, and the second with the difference of longitude between Catania and Palermo as determined by telegraph by Ricco and Zona in 1894. After giving the details of the observations, he derives the value 6m. 54·7826s. ± 0·0055, as being the difference of longitude between the two observatories. This number concludes with the obituary notices and portraits of Giuseppe Lorenzoni and Edward S. Holden, written by A. Antoniazzi and W. W. Campbell respectively.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE Australian meeting of 1914 will always occupy a prominent place in the annals of the British Association, if only on account of the interest attaching to the proceedings of its Anthropological Section. Not only did the representatives of this rapidly developing branch of science muster in full strength, but their discussions, bearing as they did largely on Australian problems which are concerned with the most primitive of existing human types, were throughout directed to fundamentals. Needless to say, the shadow of the great war raging in Europe cast a chill over the spirits of all concerned, and it needed a certain moral effort to carry through a programme in which, at least as originally designed, business and pleasure claimed equal shares. As it was, the inclination of the balance towards the side of seriousness was not without its advantage for those students who found the allotted time all too short to enable them to cope with Australia's magnificent ethnological collections. These must be seen before one is in a position to assign to Australian culture its true place in the evolutionary scale.

In Western Australia certain anthropologists of the advance party got into touch with aboriginals, and again in South Australia Prof. Stirling organised a most successful expedition of the whole section to Milang, where a large group of the Narrinyeri tribe were on view, so that everyone was presently hard at work, spurred on by the discovery that, even if degeneration has gone far, there still exists plenty of valuable lore to be garnered. It must be added that in the Adelaide Museum Prof. Stirling has amassed wealth untold in the way of ethnological material, special value attaching to the spoils from the central deserts, illustrative as they are of the life of the now famous Arunta and their congeners. At Adelaide, too, Prof. Sollas gave an evening lecture on prehistoric man, which delighted his large audience.

Formal proceedings opened at Melbourne on Friday, August 14, Prof. G. Elliot Smith leading off with a remarkable comparison of certain customs and inventions of the ancient Egyptians with those of primitive peoples of the Far East, the full development of his argument being unfortunately somewhat hampered by want of time. After Dr. A. Low had described the finding of certain curious cists of the Bronze age in the north-east of Scotland, the section adjourned to the museum. Here, first of all, Messrs. A. S. Kenyon and D. J. Mahony exhibited and explained a very rich series of aboriginal stone implements, extending from the well-polished adze at one end of the scale to the roughest Palæolithic and even Eolithic types at the other. Then Prof. Baldwin Spencer showed all manner of specimens of native handiwork, including a remarkable series of drawings on bark from the Alligator River, Northern Territory.

On Tuesday, August 18, Mr. Balfour gave forth the results of his investigations into the remains of an early Stone age in South Africa. He was followed by Dr. Marett, who, as chairman of the committee that has undertaken the recent excavation of a Mousterian cave habitation in Jersey, was able to report a rich harvest of discoveries. Prof. G. Elliot Smith and Prof. J. Symington then engaged in a discussion, scarcely less impassioned than it was profound, concerning the possibility of deducing the shape of the human brain from that of the inner surface of the cranial wall, with special reference to the primitive characters that have been attributed on these grounds to the Piltdown skull. Major A. J. N. Tremearne, who was returning next day to Europe on military duty, wound up the morning with a well-illustrated account of the Bori, or disease-spirit, ceremonies of certain Hausa colonies in North Africa. In the afternoon Prof. Felix von Luschan, of Berlin, delighted a large audience with a discourse dealing with the question, "Are we degenerate?" and embodying various more or less startling proposals of a practical nature in the interest of eugenics.

On Wednesday, August 19, the whole morning was devoted to a debate, initiated by Dr. Rivers, on the subject, "Is Australian Culture Simple or Complex?" The section listened with the greatest interest to Dr. Graebner, who holds strong views on this particular topic, and the ball was kept rolling by Prof. Sollas, Prof. Berry, Prof. von Luschan, Prof. Haddon, Rev. J. Mathew, Mr. Balfour, Mr. A. R. Brown, Dr. Malinowski, Dr. Marett, and others. The discussion as a whole was most profitable, though perhaps it raised more problems than it solved. It remains to add, in reference to proceedings in Victoria, that, besides enjoying unlimited facilities for study at the museum, and in Prof. Berry's well-equipped department of anatomy, the anthropologists had the opportunity of visiting an aboriginal quarry at Fisherman's Bend, near Melbourne, and, again, of making further acquaintance with aboriginals, since the Colanderrk station near Healesville provides types from several parts of the continent, the older members of the native community preserving considerable traces of their former culture, as witness their corrobborree songs which Prof. von Luschan was careful to record by means of the phonograph.

Arrived at Sydney, the section on Friday, August 21, was treated by Sir Everard im Thurn to a presidential address which summed up in telling fashion his impressions of the character of the so-called "savage" in the shape of the primitive Fijian. He emphasised "the enormous, scarcely conceivable difference in habit of thought which separates the savage from the civilised man," and showed on the strength of his experience as an administrator that the process of mutual adjustment, so far as it is possible at all, must necessarily be slow, demanding, too, on our part much patience, good will, and anthropological science. Dr. Ashby followed with an account of various archæological discoveries of his own at Malta. Then a most sensational announcement was "sprung" on the meeting. It appears that, just about the time that the pioneers of the British Association were setting foot on Australian soil, a highly petrified skull was found on the Darling Downs, Queensland, such as may very well prove to be assignable to Pleistocene times, Pleistocene man in Australia having hitherto existed only in the sphere of pure hypothesis. Profs. David and Wilson, who exhibited the specimen to the much-moved section, were careful to state the case for the attribution of a high antiquity to the specimen with the greatest caution, the chief argument, pending a full study of the anatomical characters, resting on the fact that the state of petrification which the skull displays corresponds closely to that observable in regard to the remains of Diprotodon and other extinct animals from the same district. The Rev. Dr George Brown then read extracts from an interesting paper on Samoan folk-lore, which he has offered to *Folk-Lore* for publication.

On Tuesday, August 25, the morning session opened with a discussion, led by Dr. Haddon, on the importance of the study of anthropology for the administrator. The president lent the weight of his great authority to the plea for a more thorough instruction of those who are set over natives in the mental habits and culture of their charges, and something was said by other speakers of what is being done by some of the British universities to provide an education in anthropology, both theoretical and applied. Dr. Rivers next spoke of gerontocracy in its bearing on marriage in Australia, showing how the old men's tendency to appropriate all available wives has in certain cases left its mark on the permanent structure of society. Mr. A. R. Brown followed with an account of the varieties of totemism in Australia, his classification covering several new types recently discovered by himself in Northern Territory, or by Mrs. Bates in the Eucla district. In the afternoon the section repaired to the museum, where local experts provided a full programme. Mr. R. Etheridge commented on various ethnological exhibits from Australia and New Guinea, being part of the rich collection over which he presides. Mr. S. A. Smith dealt with various anatomical peculiarities of the Australian aborigines. Messrs. Flashman, Hedley, Enright, and Elmore were also to thank for interesting contributions and exhibits, while a great debt is due to Prof. J. T. Wilson, who, despite the severe duties of military censor, managed to arrange for so strongly supported and well-organised a sectional meeting as that of the anthropologists at Sydney.

It has proved quite impossible to do justice here to the multitudinous experiences which, altogether apart from the formal proceedings of the section, have served to make the Australian visit of the association, and of the anthropologists in particular, at once pleasant and profitable in a quite unique way. The unfailing kindness and hospitality shown by our overseas brethren one and all make it a too invidious task to assign special thanks, and it must suffice, by way of showing due gratitude, to see to it that, in the way of science, Australia's myriad wonders and excellences are henceforth rated at their proper worth. As for the anthropologists in particular, they cannot be accused of having neglected Australia, since it has ever been the happy hunting-ground of the theorist seeking to reconstitute the life of primitive man; but at any rate it is likely that henceforth the study of Australian problems will proceed more intensively, inasmuch as the astonishing wealth of the Australian museums has been realised from near at hand. Moreover, we come away feeling that we have left on the spot plenty of men capable of carrying out the best kind of anthropological work, if only those in control of ways and means can be induced to make proper provision for a branch of study in which Australia might well aspire to lead the world.

THE IRON AND STEEL INSTITUTE.

ONE of the most noteworthy of the papers which was to have been presented at the Paris meeting, abandoned on account of the war, describes a new method of heating blast-furnace stoves. It appears from experiments on a stove carried out at the Neunkirchen works of Messrs. Stumm Brothers that, in their ordinary practice, of the total heat put into the stove about 26 per cent. was carried away in the waste gases and 18 per cent. was lost by radiation. Accordingly the efficiency of the stove was not more than 56 per cent.

As the author, Dr. Spannagel, points out, it is almost the universal practice to heat the stove for three to five hours and then send the blast through for one to one and a half hours. Messrs. Pfoser and Strack set themselves the task of finding out why the chequer work gives up its heat to the blast in a so much shorter time than is required to collect the heat from the waste gases, and they found that it was due to the fact that the velocity of the gases is different in the two cases. Under present conditions, when the temperature of the stoves is required to be raised the velocity of the gas is increased, and this causes the temperature of the waste gas to rise. Hence the waste gas losses are increased and the efficiency is reduced. The experimenters found, however, that this rule only holds up to a certain point, and that if the velocity is increased still further the temperature of the waste gas not only ceases to rise but begins to fall. The reason for this is probably that with a low velocity gas the molecules flow almost parallel to each other and the friction with the bricks is inconsiderable and consequently it is only the molecules which flow close to the chequer brick which transmit their heat by direct contact, whereas the remainder impart their heat slowly by radiation. If now the velocity is increased to the usual extent, the friction of the gas molecules against the brick causes some eddying in the outer layer of gas, and the inner particles are partly drawn into movement. The heat transmission is more rapid, but since the gas velocity is greater more heat is carried off unused. By raising the velocities still more the friction between the gas molecules and the brick becomes so great that the particles rebound and impart their rapid movement to those even in the centre of the current. Accordingly, the violent eddying produced brings all the molecules rapidly in contact with the chequer brick, and they give up their heat rapidly. Hence the temperature of the waste gas falls. The principle of the method, therefore, is precisely the same as that of the high-speed boiler designed by the late Prof. Nicholson, and indeed the authors say, "Experiments which have already been made in boiler firing have given particularly favourable results."

In heating the stoves the velocity of the gas is brought up to the necessary point by blowing in compressed air at a pressure of about 16 in. of water. At the first trial the heating period was reduced to 1½ hours, "the temperatures of the waste gases and of the blast being 350° C. maximum, and 800° C. respectively, as compared with the former heating period of 4½ to 5 hours, and a waste gas temperature of about 700° C. maximum, the blast temperature being the same." The experimenters have found it advantageous to use highly cleaned gas, since it enables the cross section of the heating passages to be reduced and the surface of the chequer brick to be substantially increased.

One of the outstanding problems, both of the ironmaker and the steel-maker, has always been the utilisation of the heat contained in slags. It is not so many years ago that the slags themselves were wasted. At the present day the uses of the various types of slags are many and various, but hitherto their sensible heat has been unutilised. Accordingly, the paper by Mr. W. L. Johnson, of Messrs. Bell Brothers, on this enormously important industrial problem, recording as it does the results of tests that have been in progress for four years, is well worth studying. The principle of the method has been to generate steam by allowing the molten slag to flow into a suitable generator and to utilise it in an exhaust steam turbine. In the first tests the steam was utilised direct from the generator, but these were abandoned in favour of an indirect method in which a water heater and a heat exchanger were introduced between the primary generator and the turbine. The calandria used was a "Kestner single-effect climbing film evaporator," and consists of two parts, the calandria proper and the separator. A certain amount of sulphur was deposited, but there seems to have been very little corrosion of the tubes of the heater. A vacuum of about 9 in. of mercury was maintained in the separator so that the water boiled at 90–91° C. "With steam from the slag at 100° C. and keeping a temperature in the calandria of 91°, the mean of twenty-two experiments gave 173 gallons of water evaporated per hour, and the average steam per hour condensed in the calandria and heater was 190·2 gallons. The feed water entered the heater at an average temperature of 24·6° C., and entered the calandria at an average temperature of 89°, *i.e.* 91 lb. of clean water was evaporated for every 100 lb. of steam from the slag." The amount of available steam from the slag was determined by condensing and measuring it. Seven experiments gave as a mean 1017 lb. per ton of slag. Deducting 6·6 per cent. for escape with the incondensable gases, 950 lb.

remain, and 90 per cent. of this gives 855 lb. of clean steam available for the turbine. "Since modern exhaust steam turbines with a full load and a vacuum of 28½ in. can be guaranteed under the above conditions to use not more than about 27 lb. per horse-power, this gives 31·6 horse-power per hour per ton of slag per hour."

In his paper on the use of liquid ferro-manganese in the steel processes, Mr. Axel Sahlin points out most of the methods of adding ferro-manganese are wasteful both from the point of view of heat efficiency and the percentage of manganese oxidised. He describes a new type of arc furnace invented by Mr. Ivar Rennerfelt, which he claims has been successfully used for this purpose. This furnace is fitted with three electrodes so placed that, when the current is turned on, the arcs, instead of passing directly between the points of the electrodes are deflected downwards, forming an inverted arrow-head or "fleur-de-lys" with a height of 6 to 12 in. Adjustment is made so that the point of the "arrow-head" impinges on the surface of the metal. Manganese smoke was noticed for a few minutes after charging, but then ceased to be evolved. The tests which have been carried out indicate that for the melting of one ton of 79 per cent. ferro-manganese, charged into an empty and pre-heated furnace, about 450 units are required. This corresponds to a furnace efficiency of 78–79 per cent., and is very much better than anything that has been achieved with other types of electric furnace. Moreover, analyses showed that there was not only no loss of manganese and iron in the melting process, but even a gain of 0·6 per cent. in each case.

The industrial production of electrolytic iron now appears to be entering the "practical" stage. An account is given by Prof. Guillet of the manufacture of such iron in the form of tubes of considerable size. The direct production of sheets is also contemplated. The iron is deposited on a revolving kathode from a neutral solution of iron salts (the composition of which is not given), the electrolyte being maintained neutral by the circulation of the liquid over the surface of the iron. From time to time the liquid receives additions of iron oxide with the object of reducing the deposition of hydrogen on the kathode. In this way currents of 1000 amperes per square metre have been successfully employed, and an iron of excellent quality is said to have been obtained. Analyses show that it is very low in the usual impurities even when prepared from very impure pig-iron. When freshly prepared it is hard and brittle, partly on account of the fact that it has been deposited in a condition of strain and partly because it contains hydrogen. The former aspect is well seen in the photomicrographs, which reveal a typical martensitic structure, and it is interesting to observe that the normal polygonal structure of a pure metal is not obtained until the annealing has been carried to 800°–900° C. Photographs of the crushing tests of tubes indicate a very remarkable degree of plasticity. The direct production of sheets without rolling would certainly be an important technical achievement and such material on account of its high degree of purity would have important applications in electrical machinery.

H. C. H. CARPENTER.

PAPERS ON HEREDITY.

STUDENTS of heredity have followed with the greatest interest Dr. L. Doncaster's experimental and cytological work with the Magpie Moth (*Abraxas grossulariata*). In the last number of the *Journal of Genetics* (vol. iv, 1914, pp. 1–21, plates i–iii) he brings forward further interesting results on the relations between chromosomes, sex-limited transmission, and sex-determination in that insect. He confirms the observation that in a strain of Abraxas, which in each generation produces families consisting entirely of females, the oogonia have only fifty-five chromosomes instead of the fifty-six normal to the species. It is thus established that the females are here heterozygous as regards sex-character, whereas in many insects the males are known to be heterozygous. Dr. Doncaster found that one female of this remarkable strain carried fifty-six chromosomes, while other females of the same brood had clearly fifty-five. "In the same brood there was failure of sex-limited inheritance of the *grossulariata* character [as contrasted with the factor producing the variety *lacticolor*] in two cases, in such a way that the *grossulariata* mother transmitted this character to two of her daughters (out of a total of sixteen) instead of, as normally happens, only to her sons. It is suggested that this may be correlated with the extra chromosome found in one female of this family, the *grossulariata*-bearing chromosome having become separated abnormally from the sex-chromosome."

Another noteworthy recent paper on the problems of inheritance is Dr. Leon J. Cole's account of the relations of the principal colours in Pigeons (*Rhode Island State College*, Bulletin 158). He concludes that there are four principal factors concerned—two for the pigments black and red, an intensity and an extension factor. The absence of the intensity factor makes black dun and red yellow, while the absence of the extension factor produces blueness. "Reversion to the wild blue Rock Pigeon type in domesticated pigeons is due simply to a recurrence of the particular combination of factors which are present in *C. livia*." White plumage is explained by the presence of an unknown number of pigment-inhibiting factors which are supposed to check the appearance of colour on different regions of the body.

THE PLACE OF WISDOM (SCIENCE) IN THE STATE AND IN EDUCATION.[1]

"So soon as men get to discuss the importance of a thing, they do infallibly set about arranging it, facilitating it, forwarding it, and rest not till in some approximate degree they have accomplished it."—CARLYLE.

THIS, doubtless, is a true statement; the difficulty is, however, to persuade men of the importance of a thing. We come to persuade you. As an association we are now eighty-four years old: our main purpose has been to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress—let me also add, its application to culture and to the public service.

By holding meetings, year after year, in the principal towns of the British Isles, the association has at least brought under notice the fact that science is a reality, in so far as this can be testified to by several hundreds of its votaries meeting together each year to consider seriously and discuss the progress of the various departments. On the whole, dilettanti have had little share in our debates. The association has already carried the flag of knowledge outside our islands, thrice to Canada and once to South Africa; now, at last, we make this great pilgrimage to your Australian shores; still we are at home. What message do we bring with us?

In 1847, when this city was but an insignificant town, it was visited by an Englishman who afterwards became eminent not only in science but also as a literary man—Thomas Henry Huxley; he was then surgeon on board the surveying ship *Rattlesnake.* In 1848 Huxley visited Sydney, and there met the gracious lady, only recently deceased, who became his wife. In after years he achieved a great reputation on account of his services to education.

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[1] From an address to the Educational Science Section of the British Association at Melbourne, August 14, by Prof. Henry E. Armstrong, F.R.S.

Lecturing in London in 1854, he defined science as "trained and organised common sense"—a definition often quoted since; none could be more apposite, though it must be remembered that "common sense," after all, is but an uncommon sense.

A few years later, in a public lecture at South Kensington, Huxley spoke to the following effect:—

"The whole of modern thought is steeped in science; it has made its way into the works of our best poets and even the mere man of letters, who affects to ignore and despise science, is unconsciously impregnated with her spirit and indebted for his best products to her methods. I believe that the greatest intellectual revolution mankind has yet seen is now slowly taking place by her agency. She is teaching the world that the ultimate court of appeal is observation and experiment and not authority; she is teaching it the value of evidence; she is creating a firm and living faith in the existence of immutable moral and physical laws perfect obedience to which is the highest possible aim of an intelligent being.

"But of all this your old stereotyped system of education takes no note. Physical science, its methods, its problems and its difficulties, will meet the poorest boy at every turn, and yet we educate him in such a manner that he shall enter the world as ignorant of the existence of the methods and facts of science as the day he was born. The modern world is full of artillery: and we turn our children out to do battle in it equipped with the shield and sword of an ancient gladiator.

"*Posterity will cry shame on us if we do not remedy this deplorable state of things. Nay, if we live twenty years longer, our own consciences will cry shame on us.*"

These words were uttered in 1861. Now, after more than fifty years, not twenty merely, we still go naked and unashamed of our ignorance: seemingly, there is no conscience within us to cry shame on us. I have no hesitation in saying that, at home, at all events, whatever your state here may be, we have done but little through education to remedy the condition of public ignorance which Huxley deplored. In point of fact, he altogether underrated the power of the forces of ignorance and indifference; he failed to foresee that these were likely to grow rather than to fall into abeyance. In England, what I will venture to term the Oxford spirit still reigns supreme—the spirit of the literary class—the medieval spirit of obscurantism, which favours a backward rather than a forward outlook.

Wherein was Huxley out in his forecast? In 1861 the claim of science was already strong, but think what has been done since that time—what we can now assert of its conquests! In the interval, even within my recollection, the whole of our ironclad fleet has been created, rifled cannon, smokeless powder and dynamite have been introduced, and this last, in combination with the discovery of the causes of yellow fever and malaria, has made the Panama Canal possible, an entirely revolutionary work of man's interfering hands. The *Great Eastern*, which could not be launched at first on account of her size—as a lad, I saw her sticking in the stocks—was always a failure, because she was outside the fashion of her time, yet has given rise to a host of ocean leviathians of far larger size; the steam-turbine has entered into rivalry with the reciprocating steam-engine; cold storage has revolutionised ocean transport, so that fresh food can be carried from this continent to remote England and Europe. Electricity, then a puling infant, is grown to giant size; not only have we deep-sea telegraphy and mechanical speech in the form of the phonograph and telephone, but wireless communication, the electric light, electric transmission of power, electric traction—even the waterfalls of the world are tamed through the turbine and made subservient to our will for motive purposes or in the production of temperatures bordering on those of solar heat, by means of which, too, we can draw food for plants, at will, from our atmosphere by combining its constituents into the form of a fertiliser. The use of oil-fuel in the internal-combustion engine has been made possible and, in a few short years, our streets have been cleared of horse conveyances and crowded with motor-vehicles; such engines are coming into use everywhere and have enabled us successfully to perform the feat which Dædalus vainly attempted—we even talk of flying from New York to London, across the vast Atlantic, to spend the week-end. The cyanide process has been introduced into gold-mining and is enabling us to unearth a fabulous wealth; a vast array of gorgeous colours has been produced, and Dame Nature so outwitted that we make indigo and madder out of the tar which in old days was put only upon fences; Pasteur's work has made Listerism possible, so that nothing is now beyond the surgeon's art and bacteriology is become the handmaid of preventive medicine and sanitary science; not only paper but a silk is made artificially from wood-pulp and the finest of scents are conjured out from all but waste materials. A multitude of other discoveries of practical value might be referred to.

Not so long ago, when scientific research was spoken of, the cry was always *Cui bono?* What's the good of it all? Now, no one has the patience to listen to a recital of the benefits accruing to mankind from its operation; for all the achievements I have referred to *are not the work of mere inventors* but primarily the outcome of scientific discovery: thus our modern command of electricity is very largely traceable to the labours of the great philosopher Faraday, who worked in an ill-lighted and cramped laboratory in the Royal Institution in Albemarle Street, London, with no other object than that of contributing to the advancement of knowledge.

Perhaps the greatest of all the scientific achievements of our time remains to be mentioned—the promulgation of the doctrine of evolution by Charles Darwin. Few perhaps can realise what this means for mankind, the intellectual advance it constitutes—that through it we have at last acquired full intellectual freedom and the belief that it rests with ourselves alone rightly to order our lives; that by it all dogmas have been undermined.

Science is come into being and has prospered only since freedom of thought was secured: on no other terms can it be. It is well that we should bear this in mind. The growth of numbers and of democracy may well involve a restriction of freedom in all directions—none are so intolerant as the ignorant.

If in science, to-day, we have something unknown to former civilisations, what is its influence to be on the future of the world, in particular on the future of the white people? If we are not to suffer the rise and fall which all previous civilisations have passed through—rather let me say, if the period of our fall is to be retarded beyond the period our forerunners enjoyed, it will be solely because we wield and use the powers science has put into our hands: not so much those of abstract science but the broad wisdom which the proper cultivation of science should confer; hence it is that I desire to urge the absolute importance of giving, through science, a place to the cultivation of wisdom in the State and therefore in education.

Clearly, two new forces are at work in the world: not science alone but also a broad and altruistic Socialism, both the outcome of the intellectual freedom man has acquired since the deposition of the Churches. The one is gradually leading us to base our actions upon knowledge and to be practical through the use of theory; the other is leading us gradually, though slowly, to have consideration for one another, to recognise how helpless are the majority, how greatly they stand in need of the guidance of the few who are capable of leading. But we shall need to order our Socialism by science to make it a wise Socialism. The signs are only too numerous that a wave of political despotism may come over us. Either, as time goes on, science will be more and more of service in guiding the social machine—or that machine will perish, from the very complexity of its organisation and the inability of the units to understand their place, to understand the need of subordinating their individual inclinations to communal interests; most important of all, to understand their inability to recognise and require competent leadership—for science is aristocratic in its tendencies: indeed, I shall claim that real science—wisdom—is for the very few.

With all the marvellous growth of achievement to which I have referred, there has been no proportionate growth of public intelligence. Our Admiralty, and to a far less extent our War Office, have called science into their service, but our public departments generally will have none of it. Even the elements of an understanding of the methods of science are not thought to be essential to the education of a Civil Servant; such knowledge is not required even in the highest branches of the Indian Service—no politician is for one moment supposed to need it: we are governed almost entirely by the literary spirit.

The spirit of the age, in fact, is in no way scientific, though ease and comfort are now provided on an unprecedented scale through the agency of science, the engineer acting as chief interpreter. Why do we still go naked and unashamed of our ignorance of "science"? One main reason is that the party in power is unscientific; but at bottom, I believe, the difficulty is a far greater one and probably innate in our disposition. It cannot well be supposed that man is by nature disposed to be scientific. The scientific fraternity, at any time, are, and probably always will be, but a small party—a set of freaks, sports from the multitude. They think and talk in a language of their own, as musicians do. The multitude may listen to them at times, with more or less of pleasure, as they do to music; but it is impossible, and probably always will be impossible, for the many to appreciate the methods and results of the scientific worker. Science, in reality, is a form of art and true artists are never numerous; moreover, it is admitted that they are born—like Topsy, they must grow, for they are not to be made in numbers. Our schools are for the most part in literary hands: and it would almost appear that literary and scientific interests are antagonistic, so unsympathetic has been the reception accorded to science by the schools.

Parenthetically, let me here deny the accusation not infrequently made by literary writers that the scientific fraternity are trying to oust literary studies from the schools. Nothing could be further from the truth. We are always craving for better literary training; our complaint is that the methods and subject-matter of literary training are far from being properly developed and, especially, that English is neglected in the schools. Huxley stated the real situation in saying, "Science and literature are not two things but two sides of the same thing."

The rise of science is due to the introduction of the experimental method. Mr. Balfour, in arguing, as he has done recently, that science rests upon many unprovable postulates and therefore does not differ in method from metaphysics, has made assertions which cannot be allowed to pass as correct. True science rests wholly upon fact and upon logic: all else is mere provisional hypothesis—a garment we are prepared to put aside at any moment if cause be shown. We are well aware that human nature is always intervening to spoil our work; it is human to err and false doctrine may easily occupy the attention for a time, but we are fully conscious of our limitations and prepared to admit them, whilst we feel that we are ever advancing towards security of knowledge.

The method of science, indeed, is the method of the Chancery Court—it involves the collection of all available evidence and the subjection of all such evidence to the most searching examination and cross-examination. False evidence may be tendered and for the time being accepted; but sooner or later the perjury is discovered. Our method, in fact, goes beyond that of the courts: we are not only always prepared to reconsider our judgments but always searching for fresh evidence; we dare to be positive only when, time after time, the facts appear to warrant a definite conclusion. But there are few instances in which we have travelled so far. The Newtonian theory of gravitation, the Daltonian theory of atoms, are two striking examples of generalisations which fit all the facts, to which there are not known exceptions; should any exception be met with we should at once doubt the sufficiency of such theories. In cases such as Mr. Balfour has discussed—the problems of metaphysics and of belief—experiment and observation are impossible: we can only resort to speculative reasoning; our belief, if we have one, is necessarily founded upon intangibilities and desires.

> There was a door to which I found no key:
> There was a veil past which I could not see;
> Some little talk awhile of Me and Thee
> There seemed—and then no more of Thee and Me.

The awful problem before us at the present time is to decide which direction we will take, to what extent and in what way we have the right to teach things which transcend our knowledge; the way in which truth lies may be clear to some of us but can never be to the majority. Those who wrap up such matters in a tangle of words are not helpful, to say the least. However mellifluous the terms of Bergsonian philosophy may be, they do not bear analysis when the attempt is made to interpret them; their effect is merely sensuous, like that of cathedral music.

But in order that she may lead, science must herself set an unimpeachable example—far too much that is now taught under the guise of science is pure dogma; in fact, the philosophy of the schools is mostly dogma. The true legal habit of mind is insufficiently cultivated and but rarely developed even among scientific workers—our logic is too often imperfect. In science, as in ordinary life, party politics run high and scientific workers are usually, for the time being, party politicians. We are too often crass specialists, always very human: indeed, whatever the lines along which evolution has taken place, they cannot well have been such as to favour in any considerable degree the development of the proclivities which distinguish the scientific inquirer: time after time, doubtless, he has been knocked on the head.

The difficulties under which science labours in our schools are partly internal, partly external. Tradition and the type of mind of the average teacher favour set lessons and literary study by blocks of learners; the extra cost of the work is considerable, when the expense of the special requirements is taken into account; more time and more individual effort are demanded both from teacher and from taught; freedom is hampered by the need of considering the requirements of external examinations; finally, the universities have done but little to help, and though the schools have more or less unwillingly recognised that there is some value in scientific studies, in consequence of the persistent demands men such as Huxley have made, more especially because it is seen that there is money in them, none the less there is still no real demand for them on the part of the public. Of this and, in fact, of nearly all the real problems of education the public are too ignorant to be judges.

Having been more than forty years not only a teacher but also a student of students and of teachers, of educational methods, and of the conditions under which teaching is carried on, I have been led to form very definite opinions, the more so as I have been able to regard the problems not only from the pedagogic side, but also from that of the chemist and biologist—with some knowledge of the mechanism.

My view—and it is one that I desire to press to a logical conclusion—is that we must recognise that human ability is not merely a limited quantity but that it varies enormously not only in quantity but also in quality: the human orchestra contains a great variety of instruments differing in tone and range, but nature, like man, makes few instruments of superlative excellence, a vast number of very poor quality and only a moderate proportion of serviceable type. If science can tell us anything, it is that the democratic and republican ideal of equality is the veriest moonshine—a thing that never has been and never will be. And education can do very little to alter the state of affairs: it cannot change the instrument, at most it can develop its potentialities, and it may easily, by careless handling, do damage to the working parts. To take a special case, of interest at the moment, no contention is less to be justified, I believe, than that which has been put forward frequently, of late years, on behalf of women—that their disabilities are in no small measure due to the fact that we have neglected their education: give them time to educate themselves and they will be as men in all things. Years ago, at our Stockport meeting, I ventured to express the difference by saying that woman is not merely female man but in many respects a different animal: the two sexes have necessarily been evolved to fulfil different purposes. Nothing is more instructive in the history of modern educational progress than the fact that women have asked merely for what men have: at the universities they have attended the men's courses; not one single course have they demanded on their own account. Higher teaching in relation to domestic science so-called has only been thought of very recently and mainly because men have urged its importance. Most serious and, I believe, irreparable injury is being done to women, in London especially, by forcing them to undertake the same studies and to pass the same university examinations as the men: and the damage is done to the race, not merely to individuals, as the effect of education, whether direct or indirect, is clearly to diminish the fertility of the intellectual. Some day, perhaps, when the present wave of selfishness has passed over us, a rational section of women will found a woman's university where women can be taught in ways suitable to themselves without injury to themselves. In saying these things, of course, I am laying myself open to the charge of narrowness—in deprecation I can only say, that what we are pleased to call education is, for the most part, so futile in substance and in its results that I shall not mind in the least if I am accused of decrying it: in my opinion, we shall all be better without most of it, men and women alike. So far as so-called intellectual education is concerned, learning to read seems to me to be the one thing worth doing: at present it is the thing most neglected in schools.

To develop a rational system, we need to take into account man's past history and to apply evolutionary and biological conceptions. Education, as we know it and practise it, after all is a modern superstition—something altogether foreign to the nature of the majority of mankind; it is based on the false assumption that we can all be intellectual; whereas most of us can only use our hands. But the schools neglect hands and attempt the impossible by trying to cultivate non-existent wits. Man is doubtless pretty much what he was, and it is useless trying to make of him what he has never been.

We are seeking to educate all. What does this mean? Practically that we are seeking to teach all to read. But when they have learnt, what are the majority to read—what will they care to read? At the schools for young gentlemen, the reading taught hitherto has been mostly the reading of Latin and Greek. We know the result—the number of persons above school age who can and do read either language is negligible. Some of us learn French, scarcely any learn German, Spanish is all but neglected: when, therefore, we visit the Continent of Europe or South America we can only mumble a few words of the language of the country, and usually allow the foreigner we visit to speak broken English for us: few of us read his literature.

The vain attempt is made to put us in touch with the past but no real effort is exerted to bring us into contact with the present. We have not yet taught English in our higher schools, but are beginning to think of doing so—to this end, we are urging that attention be paid to so-called classical literature, forgetting, of course, that for the most part this was written for grown-ups and not as food for babes of school age.

The difficulty is still greater in the case of those who have only passed through the elementary schools—the literature that will appeal to most of these will be very limited in scope. Our newspapers show pretty clearly what will go down: not much—but it represents what is going on in life. In London, when the theatres are under discussion, it is often said that people want to be amused, not instructed; to cudgel our dull brains is a dull business to most of us. It seems to me that this doctrine should be applied more than it is in the schools. At all events, we shall do well to remember the words of the wise pundit in Rudyard Kipling's "Kim": "Education—greatest blessing when of best sorts—otherwise no earthly use."

To discover the best sort for each sort of student is our difficulty—who will do it? Here comes my point. Not the present race of schoolmaster or of educational authority. By placing classical scholars in charge, we seem unconsciously to have selected men of one particular type of mind for school service—men of the literary type; and this type has been preferred for nearly all school posts, mainly because no other type has been available, this being the chief product of our universities. Such men, for the most part, have been indifferent to subjects and methods other than literary—I verily believe not because they have been positively antagonistic or lacking in sympathy, but rather because of their negative antagonism: of an innate ability to appreciate the aims and methods of any other school of thought than their own, especially on account of their entire ignorance of the experimental method. I believe, moreover, that the difference is fundamental and temperamental, not to be overcome by training. Oxford, owing to the bait of its classical scholarships, seems to have attracted an entirely peculiar type of ability and to stand alone in consequence; at Cambridge, owing to the hold obtained by mathematics, the field has been divided, but the mathematician, in his way, is often as unpractical by nature as the classic; fortunately, of late years, owing to the rise of the medical school and that of natural science, other elements have been introduced and the university has a future of infinite promise in consequence, if it will but realise that its primary function is to inculcate wisdom rather than to give purely professional training.

Sympathy is only begotten of understanding; the literary type of mind apparently does not and cannot sympathise with the practical side of modern scientific inquiry, because it has neither knowledge of the methods of experimental science nor the faintest desire for such knowledge.

We need a more practical type of mind for our schools. Pessimist though I may appear to be, having watched with close attention, all my life, the great struggle that has been going on in and between schools—having had the great good fortune also myself to be one of the early workers in the province of technical education, and having been associated with the development of one of the greatest of our boarding schools (Christ's Hospital)—I am, of course, aware that very great progress has been made, and am, in every way, hopeful of the future in store for those who are unaffected by present prejudices. In my experience, the men to whom the progress has been due have, in all cases, been trained in a broader school than that of Oxford; the few escapes from Oxford who have been successful reformers have been the exceptions which prove the rule, as they have shown themselves to be gifted with practical instincts: to such men the Oxford literary training has been of extreme value. Oxford will not gain its full value until all types of ability are represented in fair proportion by its students, not one almost exclusively. When this step is taken, the incubus of the Oxford spirit will no longer be upon us: it will then be possible for us to regard education as "a preparation for life"—a formula often used but usually honoured, hitherto, in the breach, rarely if ever in the observance, in our schools.

There must be no misunderstanding. The representatives of literary training rely chiefly on a past into which it is well not to look too closely and must always work with borrowed capital in the days to come: our side has no distant past worth speaking of, but is hopeful of a glorious future, in that it will always be adding to its knowledge; we desire to do their party all possible justice, and shall ever be in need of their assistance and more than grateful for the service they render us; but it must be war to the knife if they will not recognise that, in a progressive age, they cannot lead any longer, that we shall decline to put up in future with the conceit and narrowness of outlook of the classical scholar.

The argument I have applied to the teacher is equally applicable to the taught—boys and girls, indeed students generally, are of different types; they have different orders of ability and cannot be treated as if all were alike. In the beginning, we may tempt them with all sorts of scholastic diet, but only, in the main, in order to discover their aptitudes; when these are found, they should be the main line of attack. In saying this, I am not arguing in favour of extreme specialisation but against time being wasted in attempting the impossible. Some of us can learn one thing, others another: the schools try to force too many into one mould. It is essential that we should try to lay certain foundations but useless to proceed when we find that some of them cannot be laid.

This doctrine is applicable especially to the selection of scholars and to the training of teachers and of evening-class students. We select our scholars almost entirely by literary tests—the result is that we select persons of literary aptitude rather than those gifted with practical ability for every kind of service: like necessarily breeds like. By insisting on "grouped courses" we too often oblige students to take up subjects to which they are incapable of paying attention with profit: most of us, probably, have found out that there are many subjects which we simply cannot learn, try as we may.

My own experience with students has satisfied me that they not only vary in ability but that the different classes are of very different types of mind: the engineer tends to be constructive but not analytical; the analytical introspective habit of mind is more highly developed in the chemist; the biologist rarely has mathematical proclivities. It is useless to attempt to teach all in the same way, and many can learn only very little.

The explanation of Huxley's failure to forecast the future of science lies, apparently, in the fact that men generally *are not* attuned to her ways. I am inclined to think that the "mere man of letters" *will continue* to ignore and despise science—he will lack the peculiar mental capacity to assimilate scientific teaching. Only the few will rise to a proper understanding of the mysteries and be masters of their subjects, though many may be trained to be skilful mechanics.

The extent to which the multitude can receive instruction is a matter of primary importance. If, as Huxley has said, the greatest intellectual revolution mankind has yet seen is now slowly taking place by the agency of science—if she be teaching the world that the ultimate course of appeal is observation and experiment, not authority; teaching it the value of evidence: then must we strive to teach all, in some measure, what constitutes evidence, what observation and experiment are.

I believe much can be done in this direction, having made the attempt with hundreds of unwilling students in my time, students of engineering who had not only made up their minds that they were not going to learn chemistry as it was not their subject, but were incapable of ever entering into the spirit of the work—one of my sons was amongst them. At an early period, having realised that it was useless to waste my time and theirs in the struggle, and that it would not help them in the long run, to give them chemical tips which they lacked the sense to appreciate and to apply, I made up my mind, therefore, that it was desirable instead to develop any detective or inventive spirit that might be in them, so advised them to read detective stories instead of a text-book and ask themselves what the stories taught them: how the detectives set to work. Their attention was secured by urging them also to think what would be their position, later in life, when they were called upon to act for themselves and to get new knowledge for themselves, if they had not learnt to think for themselves. We have then set them to work to solve a series of problems in the laboratory. The course, in fact, was a combined laboratory-lecture course, the lectures being on and always subsequent to the laboratory work. In not a few cases, in after years, when I have met old students, they have told me spontaneously that, much as they had objected to the pressure put upon them, our insistence on their learning to do something themselves had proved to be of extreme value. Long experience has convinced me that anyone who has once learnt to make simple measurements and observations and to ask and answer a definite question experimentally is on a different mental and moral plane from that occupied by those who have had no such training.

Such teaching is possible even in elementary schools—given competent teachers; but a new race of teachers will be required to carry the work into effect, should it be decided to make the attempt at all generally.

The great mistake that has been made hitherto is that of attempting to teach the elements of this or that special branch of science: what we should seek to do is to impart the elements of scientific method and inculcate wisdom, so choosing the material studied as to develop an intelligent appreciation of what is going on in the world. It must be made clear, in every possible way, that science is not a mere body of doctrine but a method: that its one aim is the pursuit of truth.

If we are to progress in these matters, a system must soon be developed which is broader and better than that under which we now muddle along—at present the real problems of education are all but neglected; even if the official mind were capable and desirous of promoting progress, the work of administering rules and regulations—of keeping the machine going—is so great that no time is left for thought.

We have seen the error of our ways sufficiently to give up payment by results and are all but ashamed that we were ever misled by Robert Lowe to adopt such a soul-killing policy. But none the less our entire educational system is still in the grips of commercialism, and, in this respect, as a nation, we stand alone, I believe. Scholarships, prizes of one kind or another, examinations are the perpetual feast of British education. Examinations, in fact, are a regularised and very lucrative branch of industry—mostly in the hands of certain firms who diplomatically shelter themselves under the ægis of this or that educational body; but the universities are the greatest sinners. Valuable as examinations may be within certain narrow limits and for certain definite purposes, there is little doubt that our general ignorance is in no small degree determined by our worship of the examination fetish. So long as the system prevails, the education of our youth will not be in accordance either with their capacity or their requirements but on lines corresponding to those by which prize cattle are raised for show—they will be trained to develop some specially catching point.

The examinations are an inheritance from the literary rule. It is possible to test on paper whether a man be "well read," but faculty as distinct from capacity cannot be so determined. What is worse, by forcing students to commit a large body of doctrine to memory, the attention becomes fixed merely upon what others have done and little time or inclination is left them to acquire a knowledge of method—the faculty of thinking for themselves and applying their knowledge. No class suffers more seriously than medical students under the system—their preliminary training is all but entirely didactic, and the time spent upon it all but wasted; we need not wonder that medicine has made so little advance, the practitioners being in no way trained in the use of scientific method.

To improve our system we need to get rid of our blind British belief in "men of affairs," especially in the "man of business," so-called, really the man of commerce, as persons capable of ordering everybody's affairs and everybody's business. The commercial man, the financier or the lawyer, would never think of calling us in to manage his proper business—why should he be thought competent to manage ours? Results show that he is not, as my argument in this address would lead us to expect would be the case.

No one will seek, for one moment, to minimise the progress made or fail to recognise that infinite credit is due to those who have controlled the work of education thus far; hitherto, however, progress has been made in providing accommodation and getting scholars to school and college: the art of teaching has made no corresponding advance—nor will it, I believe, until the onus is cast more directly upon the teachers and they are forced to exercise greater forethought in the direction of collective action—until they are placed in a position to be sole managers of their own affairs and called upon to row together as entirely self-chosen crews. At home, excepting at our ancient universities, "governing bodies" are paramount everywhere—not the teachers; and too often the sense of responsibility and power of initiative of the teacher are further diminished by the interposition of a principal, who may be a man of all affairs except that in hand—the work of teaching.

If the conclusion at which I have arrived be correct—that science is not for the multitude and can never be generally appreciated or even fashionable—in view of the part which it is clearly destined to play in education and in daily life, on account of its infinite and far-reaching influence upon our well-being—the responsibility cast upon the few representatives of science is very great; in support of our civilisation and in order that wisdom may prevail more generally, they must organise its forces effectively.

Whilst individuality is the mainspring of scientific progress, collective action is required to provide full and proper opportunity for the workers and to promote the success of their inquiries. At present, scientific workers are organised merely for the purpose of providing means of publishing the results of their studies, in no way either for defence or offence; our societies are not effective even for the purposes of debate and criticism. Thus, our chief English scientific society, consisting of some 500 members representative of all the various branches of physical and biological science, is little more than a rabble—its fellows are such individualists that scarce half a dozen of us can ever agree to work seriously together for a common purpose, and the irresistible influence we might exercise if we could be unanimous as to our objective is lost to the community. Most unfortunately, the society has no influence whatever either on political or on public opinion; it makes no attempt either to guide the public or to give dignity and importance to the cause of science in the eyes of the community. Its meetings are dull, and its belated publications by no means represent the scientific activity of its fellows. The presidents of the society have too often been appointed at an age when the propagandist spirit is no longer paramount, when they have no particular scientific message left in them to deliver. And they occupy the chair too long; this arises chiefly from the fact that however clear each one of us may be that individually he is fully competent to hold the office, we all agree in finding some objection to every name that is suggested; to overcome this difficulty a short tenure is desirable, so that the compliment can be paid and encouragement given to the various sciences in turn; no one should be appointed to such an office who is more than sixty to sixty-five years old, as most of us have used up our ideas and have lost our virility by that age. The other officers also hold their positions too long, but members of the council have far too short a life—consequently all the power is centred in the official body; attempts that have been made to organise the whole society in sections representative of the various sciences have always been defeated by the official party.

Unless our scientific societies can be made more generally effective, if scientific workers are incapable of learning lessons from administrative life, it stands to reason that the collective interests of science and of the body scientific must remain unrepresented and unvoiced—to the great detriment of progress and of the public.

Science must be organised, in fact, as other professions are organised, if it is to be an effective agent in our civilisation; the problems pressing upon us are of such magnitude and of such infinite importance that we can no longer afford to be without wisdom.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At Emmanuel College the exhibition of 50*l.* offered to a research student commencing residence in the present term has been awarded to L. Harrison, University of Sydney, for research in zoology. An additional exhibition of 50*l.* has been awarded to A. J. Philpot, University of London, for research in physics.

THE authorities of the Imperial College of Science and Technology, including the Royal College of Science, the Royal School of Mines, and the City and Guilds (Engineering) College, have information of some three hundred of their present staff and students who are now serving with the forces of the Crown, but they have no means of knowing to what extent old members of the college have answered their country's call. They desire it to be known that they will be glad to receive from these or their friends any particulars in respect of service and welfare which may be of interest to the college. The registrar will be glad to deal with any matters of this kind.

IN 1902 Dr. and Mrs. Christian A. Herter, of New York, gave to the Johns Hopkins University the sum of 5000*l.* "for the formation of a memorial lectureship designed to promote a more intimate knowledge of the researches of foreign investigators in the realm of medical science." According to the terms of the gift, says *Science*, some eminent worker in physiology or pathology is to be asked each year to deliver lectures at the Johns Hopkins University upon a subject with which he has been identified. The selection of the lecturer is to be left to a committee representing the departments of pathology, physiological chemistry, and clinical medicine, and if "in the judgment of the committee it should ultimately appear desirable to open the proposed lectureship to leaders in medical research in this country there should be no bar to so doing." The eighth course of lectures on the Herter foundation will be given by Dr. T. Lewis, lecturer on diseases of the heart, University College Hospital Medical School, London.

A COPY of the current calendar of University College, University of London, has been received. It is arranged on the same general lines as in previous years and provides full particulars as to the preparation for various degrees of the University, the scholarships, and exhibitions available, the facilities for post-graduate study and research, lists of graduates from the college, and much other useful information. A full account is given at the end of the volume of the assembly of the faculties of arts, laws, science, engineering, and medical sciences held last July when Sir Archibald Geikie presided. The provost, Dr. T. Gregory Foster, in his report on the work of the session 1913–14, pointed out that the progress of the college in the matter of buildings and equipment, as well as of endowment, continues to be greatly advanced by the work of the equipment and endowment fund committee, which was established in 1902. The completion of the new school of architecture and the erection of the building for the department of applied statistics and eugenics, as well as that for chemistry, had been seriously hindered owing to the labour disputes—in fact, little work had been done on either building for more than twenty weeks. The delay caused the greatest inconvenience, and it has also largely increased the cost of both buildings. The college is still short of the funds necessary to complete the equipment of the new chemical laboratories, and is looking anxiously for a benefactor who will come forward and provide the amount yet needed. It is also looking for a benefactor who will give the funds requisite for the purchase of All Saints' Church and its equipment as a great hall for the college. Rapid development of the work in almost every department, the demand and necessity for the institution of new courses and new departments, make it more difficult every day, with the present accommodation, to progress with the times and to meet the new requirements. The provost then went on to announce the grant of 30,000*l.* by the London County Council, and said that at least another similar amount is necessary to complete the works in progress. The calendar also includes a list of the honours and appointments of former students and other persons connected with the college, and a comprehensive list of original papers and other publications from the various departments of the college during the session 1913–14.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 5.—M. P. Appell in the chair.—G. **Bigourdan**: The passage of Mercury across the sun of November 7, 1914. Precautions are suggested for the observations of the forthcoming transit of Mercury.—J. **Boussinesq**: Addition to a recent note on the coefficient of filtration with sand with more or less fine grains. Calculation of the coefficient for the heterogeneous sand used by Darcy in his experiments.—L. **Landouzy**: The auxiliary hospital of the institute, No. 265.—A. **Laveran**: Experimental infection of mice by *Leishmania tropica*. Twelve white mice were inoculated, eight males and four females. None of the latter were infected, but six out of the eight males developed the disease, of which full details are given.—E. **Delorme**: General considerations on the treatment of wounds received in battle. Disease in the French Army is almost non-existent, dysentery and typhoid fever scarcely reaching the figures in times of peace. The conditions under which the present campaign is being carried out differ from those in 1870 in that battles are carried on continuously for days and weeks, and prompt removal of the wounded from the firing line is impossible. It follows that by the time the wounded are received at the rear suppuration has in many cases already set in. This especially applies to wounds caused by shrapnell and fragments of shell, in which infection by earth is common. As a result cases of gaseous gangrene and tetanus are widespread, and necessitate a complete change in the surgical practice at the front. Hospitals must now be concentrated as close to the firing line as possible, and the work to be done at these hospitals is sketched out. The frequency of complications due to gaseous gangrene and tetanus is specially mentioned, and the best means of dealing with them close up to the firing line discussed.—Remarks by A. **Laveran** on the preceding communication. Suggestions as to the best means of using anti-tetanus serum.—Observations of M. **Roux**. Remarks on anti-tetanus serum.—Reply of L. **Landouzy** to the communication of E. Delorme.—E. **Maurant**: Ephemeris of the

Delavan comet, 1913*f*.—Charles **Rabut**: New projective invariants.—P. **Helbronner**: The complementary geodesic triangulations of the high regions of the French Alps.—Aug. **Chevalier** and Olivier **Rœhrich**: The botanical origin of cultivated rice.—M. **Rollet**: The extraction of German bullets and fragments of shell by the aid of a powerful electromagnet.

CAPE TOWN.

Royal Society of South Africa, August 19.—Dr. L. Péringuey, president, in the chair.—T. F. **Dreyer**: The morphology of the tadpole of *Xenopus laevis*. Among other conclusions the author states that the epithelium of the gill-slits is continued into the glottis, which is in support of the theory that lungs and gill-slits are homologous.—R. **Issel**: A morphological study of *Strongylus douglasi*, Cobbold. A description of the ostrich wire-worm. Although the parasite was discovered in South Africa more than thirty years ago and has considerable economic importance in view of the mortality it causes among ostrich chicks, this is the first complete description of the helminth. It has been found that the parasite has a buccal cavity armed with teeth. This and other details were overlooked in the original description.—W. A. **Jolly**: The interpretation of the electrocardiogram. An explanation of the form of the electrocardiogram in the human being, under normal and pathological conditions, was put forward, based on a study of the electrical changes in the simple and slowly contracting heart of the tortoise, isolated from the body and caused to beat by induction shocks.—W. von **Bonde**: On the crystallography of anatase crystals in the auriferous conglomerate of the Witwatersrand. An occurrence of minute anatase crystals in the Rose Deep Gold Mine was described recently by Dr. R. B. Young. A number of these minute crystals was sent to the S.A. College for crystallographic examination. This work was undertaken by the author. Chemical examination showed the presence of titanium in the mineral. There is, therefore, no doubt as to the correctness of Dr. R. B. Young's determination of the mineral as anatase. A stereographic projection of all the observed faces suggests the possibility that anatase has not the symmetry hitherto assigned to it. An extended examination of a larger number of crystals is in progress with the view of confirming or disproving this suggestion.—T. **Muir**: Note on the product of a special n-line determinant by its central minor of the $(n-4)^{th}$ order. In Mr. Roseveare's paper on a proof that every algebraic equation of the n^{th} degree had n roots, an equivalent was given for the product of a special n-line determinant by its central minor of the $(n-4)^{th}$ order, the equivalent taking the form of an aggregate of products of pairs of minors of the $(n-2)^{th}$ order. For such a product an apparently similar expression of a general character has been known for some time, but it is found that this does not include the form given by Mr. Roseveare. This latter form is considered and a generalisation of it is worked out.

BOOKS RECEIVED.

Discoveries and Inventions of the Twentieth Century. By E. Cressy. Pp. xvi+398. (London: G. Routledge and Sons, Ltd.) 7*s*. 6*d*. net.

A Text-Book of Physiological Chemistry. By Profs. O. Hammarsten and S. G. Hedin. Translated by Prof. J. A. Mandel. Seventh edition. Pp. viii+1026. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 17*s*. net.

Fishing and Philandering. By A. Mainwaring. Pp. xv+254. (London: Heath, Cranton and Ouseley, Ltd.) 6*s*. net.

The Spectroscopy of the Extreme Ultra-Violet. By Dr. T. Lyman. Pp. 135. (London: Longmans and Co.) 5*s*. net.

Department of the Interior. U.S. Geological Survey. Bulletin Nos. 556, 557, 571, 580 D, 580 E, 581 A, 585. (Washington: Government Printing Office.)

Department of the Interior. U.S. Geological Survey. Water-Supply Paper 323, 340 B. (Washington: Government Printing Office.)

Department of the Interior. U.S. Geological Survey. Professional Paper 90 C, 90 D. (Washington: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. lxiv., No. 2. (Washington: Smithsonian Institution.)

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 23.

PHYSICAL SOCIETY, at 8.—Presidential Address: Ionisation: Sir J. J. Thomson.

TUESDAY, OCTOBER 27.

ZOOLOGICAL SOCIETY, at 5.30.—Report on the Rhynchota Collected by the Wollaston Expedition in Dutch New Guinea: W. L. Distant.—The Foraminifera of the Kerimba Archipelago, Portuguese East Africa: E. Heron-Allen and A. Earland.—A Remarkable New Cirripede from the Chalk of Surrey and Hertfordshire: T. H. Withers.

THURSDAY, OCTOBER 29.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address by the President.

CHILD STUDY SOCIETY, at 7.30.—After Care of Mental Defectives: Miss E. Fox.

FRIDAY, OCTOBER 30.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Thomas Hawksley Lecture: Pumping and Other Machinery for Waterworks and Drainage: W. B. Bryan.

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THURSDAY, OCTOBER 29, 1914.

SCIENCE AND THE STATE.

AT the present moment we as a nation are engaged in war; hundreds of thousands of volunteers are joining Lord Kitchener's Army; and it is evident that we are in for a long job. A forecast by the military correspondent of the *Times* of October 17 contains the following paragraph:—"This war, for us, has hardly begun. We have sent the point of our advanced guard into France to skirmish with the enemy. In the spring the rest of the advanced guard will follow, and somewhere towards the close of 1915 the main body will begin to come within view. We are not in any hurry."

With this prospect it may be fitting to inquire whether the best use is at present being made of the material at our disposal. We have multitudes of able-bodied young men willing to serve; there is no likelihood that the supply will fail; but at the worst, we can introduce compulsory military service. We can safely leave this question in the hands of our military advisers. There is also a great body of women in training as nurses, and a still larger body engaged in providing necessary warm clothing for the troops, and for the wounded. The unfortunate refugees in our country are being looked after, and in such ways the nation is rising to the demands thrust upon it. Everyone, in fact, is doing his or her best in individual and in organised effort.

But there is a class of our fellow-subjects which has as yet, so far as we are aware, not been organised. That is the Fellows of the Royal, the Physical, the Chemical, and the Engineering Societies. In their own particular provinces they are the pick of the brains of the country. This war, in contradistinction to all previous wars, is a war in which pure and applied science plays a conspicuous part. Has any effort been made to coordinate the efforts of the devotees of physical, chemical, and engineering science, so that they may work together at what for us is the supreme problem of all—how to conquer the Germans? For if we fail, civilisation as we know it will disappear. Democratic rule will have to yield to a military oligarchy. It was pointed out in an article in NATURE of October 8 how the originality in science of the Germans has decreased during the past generation, in spite of their enormous output of literature; this is to be attributed, no doubt, to the restraining influence of a military despotism, which has pervaded all aspects of their life. But in the design and manufacture of their war-material they have worked incessantly for years in their usual methodical manner, trusting rather to myriads of experiments than to the utilisation of original thought, which is for them in a great measure lacking.

The problems which at the present moment require the help of our scientific men are varied and numerous. Our first efforts must be to aid our military forces in suggesting and supplying them with all kinds of appliances and material of which they can make use in vanquishing the enemy and in defending our shores. We know, of course, that expert advisers have been attached to our ordnance factories, to our navy, and to our air-service for years, who have doubtless done much in preparation for the fierce struggle now in progress. But in war, *every man* who has special knowledge of physical, chemical, and engineering problems which confront the authorities responsible for the conduct of the war should be summoned to do his best.

It is not to be expected that under the enormous pressure at which they are working, the authorities of the War Office will have time or strength to effect an organisation such as is here suggested; to create such an organisation must be the duty of the councils of the chief scientific societies and of the British Science Guild; they must offer voluntary aid. A practical method of carrying out this recommendation would be for each council to consider in what way help can be given. It is for the Royal Society to set the example; among its fellows are to be found the *élite* of scientific men, belonging to all the scientific societies. A number of committees should be appointed, small at first, but with power to add to their number; each committee would draft out lines on which its members might advantageously work, and the committees might be strengthened by adding fellows or members of other societies, known for their special acquaintance with the conditions of each particular problem. Such services would, of course, be voluntary, and should be considered as one contribution of men of science to the relief of national needs.

It may be contended, however, that bodies of men such as those suggested have not the practical experience necessary for putting those of their ideas which promise useful outcome into a shape required for present emergencies. This contention, if it should be made, has little weight. There is much contact between those who have devoted their lives to the advancement of the domain of pure science and those who have interpreted its results in practice; not so much, perhaps, as might be desired, but enough to make it possible to enlist the services of practical engineers, electricians, and chemical manufacturers in bringing to a practical issue any ideas which may commend themselves. Indeed, such men as might serve on the committees might do much to organise the efforts of manufacturers, so that no overlapping should occur, and in such a manner that the utmost efficiency should be secured.

It would be well, too, that some means should be adopted whereby these committees should come into contact; an engineering problem, for example, often requires co-operation from the physicist or chemist for its successful solution. Such co-operation, however, should not be difficult to arrange for.

We referred last week to the publication of a reasoned statement by British scholars, as a reply to a manifesto by German professors. This is all to the good; but we need action as well as words. Action is being taken by the Master of Christ's College, Cambridge, and the secretary of the Appointments Board of the University, to form a committee of members of that University to advise the "Entente Trade League." Here, again, is an effort in the right direction; but it cannot be too strongly emphasised that WE ARE AT WAR, and the first duty of all men of science must be to organise, and to place their services unreservedly at the disposal of our War Office.

In this hour of national emergency there is no time to be lost. We cannot all be soldiers, but we can all help, we men of science, in securing victory for the allied armies. Every day lost means the destruction of a number of our fellow-countrymen and of our allies, and the sooner we co-operate for the good of the nation the sooner will the war be over.

CROPS, STOCK, AND SOIL.

(1) *The Natural History of the Farm: A Guide to the Practical Study of the Sources of Our Living in Wild Nature.* By Prof. J. G. Needham. Pp. 348. (Ithaca: The Comstock Publishing Co., 1913.) Price 1.50 dollars.

(2) *Investigation into the Disease of Sheep called "Scrapie" (Traberkrankheit; La Tremblante): With Especial Reference to its Association with Sarcosporidiosis.* By Dr. J. P. M'Gowan. With an Appendix on a Case of Johne's Disease in the Sheep. (Edinburgh and East of Scotland College of Agriculture.) Pp. ix+116. (Edinburgh: Wm. Blackwood and Sons, 1914.)

(3) *Die Typen der Bodenbildung, ihre Klassifikation und geographische Verbreitung.* By Prof. K. Glinka. Pp. iv+365. (Berlin: G. Borntraeger, 1914.) Price 16 marks.

(1) PROF. NEEDHAM'S "Natural History of the Farm" is one of those books that could only be written in America, where individuality of outlook is allowed, not only to a professor of limnology, but to all who are engaged in doing anything with agricultural students. For it is recognised that the methods must not become stereotyped and that every teacher should have his own way of doing things. This book is a combination of natural history and nature-study, with much fluent writing about the joy of communing with nature and the things that really count in life; the chapters are ushered in with quotations from Robert Burns, Ecclesiastes, Whittier, Micah, etc., and along with the fluent writing is set a practical exercise. Anyone who knows the American student, with his (and especially her) capacity for taking things seriously, will realise that a book of this kind will get its chance, and that the intention of the author will be duly respected. His aim is not so much to teach as to arouse such interest in country life that men and women shall remain in the country and not migrate to the town. We have the same problem ourselves, and may yet have to deal with it in the same manner.

(2) Dr. M'Gowan's book deals with a disease in sheep which has become widely known in some of the border counties during the last few years, especially in Roxburghshire and in Northumberland. The symptoms exhibited are persistent itching without any evidence of "scab," a gradual emaciation, but no diarrhœa or loss of appetite, a change in gait and a weakening of the muscle power; the disease is almost universally fatal. It is known in the north as "scrapie," but it appears to be identical with diseases described by older writers as rickets, goggles, shakings, cuddie trot, etc., and with "la tremblante" and the "traberkrankheit" of the Continent.

The author's investigations lead him to believe that it is caused by a heavy infection of the sheep with a protozoan parasite (sarcosporidium). He attributes the infection to the system in vogue in the north of breeding from the two-year-old ewes for the purpose of keeping up the ewe stock; he finds no evidence that the disease is spread by the ram. His reasons for attributing the disease to the sarcosporidium are (1) that the sarcocyst is always present in the skeletal muscles of affected sheep in large numbers, the more advanced the disease the larger being the numbers present; (2) the itching can be reproduced in rabbits by infection with sarcosporidial emulsions. It would be more satisfactory to have the complete demonstration with sheep instead of with rabbits; but no doubt this will come. In the meantime Dr. M'Gowan has to admit that he has no treatment to suggest, but recommends that the affected animals should be sent to the butcher before their case has become too serious, whilst the ewe stock should be kept up from the progeny of animals older than two years. Inbreeding also should be conducted with great caution.

(3) The study of the formation of the soil owes much to the Russian investigators Dokutschajeff, Kostytscheff, Sibirceff, Glinka, and others, and in this volume we have a very convenient summary of what they have done, and a good description of Russian soils by one of the best of the modern Russian workers. One of the troubles of the past has been the lack of a widely-accepted system of classification; several have been proposed, but none has been universally adopted. It is largely to the Russian investigations that we owe the possibility of a definite system; their insistence on the necessity for more adequate recognition of climatic factors has widened our views on the subject and enabled better groupings to be made. More survey work has still to be done before a final classification can be set up, but in the meantime the scheme outlined in the present book is of distinct value.

The author recognises two great groups of factors in soil formation: internal factors—such as the composition of the rock—and external factors, such as climate. He accordingly sets up two great classes of soils: endodynamomorphic, in the formation of which the internal factors have predominated, so that the properties of the soil are governed by the properties of the originating material; and ectodynamomorphic, where the external factors predominated, the influence of weathering and transporting agents, the climate to which the soil has been exposed, etc., having outweighed the effect of the composition of the original material in determining its properties. Examples of the first are the various black soils containing calcium carbonate, which he calls rendzina soils. These include our fen soils, the black earths (tschernosem, etc.). The ectodynamomorphic soils are subdivided into six groups according to the amount of washing they have received during the process of formation. The tropical "laterite" soils come at one end of this chain and the alkali soils at the other. There are, of course, transition forms, but in the main the world's soils fall fairly easily into the scheme. The book will be read with much interest by all students of the soil.

E. J. R.

THE EVOLUTION OF PHILOSOPHICAL THOUGHT.

Greek Philosophy. Part i, Thales to Plato. By John Burnet. Pp. x+360. (London: Macmillan and Co., Ltd., 1914.) Price 10*s.* net.

THIS is the second volume of a series by various writers entitled "The Schools of Philosophy," and edited by Sir Henry Jones, professor of moral philosophy in the University of Glasgow. The author states in the preface that his chief aim has been to assist students who wish to acquire a first-hand knowledge of what Plato actually did say in the dialogues of his maturity. He should be eminently fitted for this task, as he was Taylorian scholar in 1885, and ever since he has kept himself immersed in Greek literature.

In a footnote on the last page he states that he has edited the whole text of Plato, and the usual books of reference give a list of his other works, which are all connected with the Greek classics. This footnote, however, like a woman's postcript, contains the key to his mind, as it begins by saying that he was drifting into a "hopeless scepticism," from which apparently he now believes himself convalescent. Yet he begins the introduction with the paradoxical words: "No one will ever succeed in writing a history of philosophy." The catalogue of the British Museum provides one horn of the dilemma, and his latest book supplies the other. It deals with philosophers, or with some of the greatest and earliest, but it contains no information likely to assist the rising generation of undergraduates and philosophers in ascertaining what were the ideas these ancients were groping after. Only by a supreme effort of the maieutic art could a student ascertain from the book itself that in physics one of their greatest stumbling blocks was the equation of motion of a falling raindrop, $\frac{dv}{dt}=g-g\left(\frac{v}{H}\right)^n$ which they only had under observation when v was equal to H.

The discussion of this problem is noticed by Duhem in his article, p. 272, "Roger Bacon et l'horreur du vide," in the commemoration volume of Roger Bacon essays just published. The word "natural" attached to motion always presupposes a gravitational cause. The horror of the void arises from the metaphysical notions derived from Aristotle now embedded in scholastic or neoscholastic philosophy where "form" combined with "matter" (or Clerk Maxwell's æther) produces "substance" which in turn supports "accidents," which latter alone constitute the subject-matter of inquiry of modern physical science. They give rise to the three indefinables of nature, weight, time, and space. A void by definition contains no "matter," and therefore no "accidents," and is without dimensions. It is dismissed by Aristotle as an absurdity, as a hole in the æther.

As regards the religious philosophy of the Greeks, they were groping for the metaphysical essence of "Actus Purus," or of God. Whether or no the chief attributes of God are explicitly known to every modern, it cannot be denied that they are enshrined in the English language, and form the subject of some of the finest passages of the English classics. To name a few of those not to be found in the Greek classics, self-existence, infinity, unity, simplicity, immensity, omnipresence, immutability, eternity; it was of these that Plato said, when asked as to his doctrine of the Good, "There is no writing of mine on this subject, nor ever shall be," words suitable for those times before the power that created the universities of Paris, Oxford, Cambridge, and eke St. Andrews, had come into the world.

Some hundreds of sentences in the book begin with the word "now," and on p. 118 we are told that Hippias's curve, the quadratrix, would solve the problem of squaring the circle by a geometrical construction if it could be mechanically described. It is well known that Hippias himself made an instrument to draw his curve, and any schoolboy can imitate it. J. H. HARDCASTLE.

A NORTH AFRICAN RACE.

The Eastern Libyans: An Essay. By Oric Bates. Pp. xxii + 298 + xi plates. (London: Macmillan and Co., Ltd., 1914.) Price 42*s.* net

IN this excellent monograph Mr. Bates has collected a rich store of facts relating to the ancient Libyan people, which will be of the greatest value to workers in many fields. Besides the strictly archæological side of his subject, he has also treated fully the physiography of the region, so that the whole subject is given a definiteness and actuality which may be imitated with advantage by writers on similar subjects.

The region over which these people formerly moved is a wide one, and eastern Libya, with which this work is concerned, extends from the west of Tripoli to the Nile Valley. This part of Africa is crossed by many routes of caravans and travellers, yet few portions have been seriously examined by qualified investigators, but from the material available and from his own observations Mr. Bates has produced a very accurate account of this area, which geographers will find of real worth.

In treating of the ethnology and ethnogeography the author has been able to come to certain conclusions from a discussion of Egyptian, classical, Berber, and Arabic data, which seem to indicate that the Libyans were pushed back from the seaboard, and from the oases to the westward, and the outcome of this was the periodical aggressions on the Nile Valley whenever that country was weak and the prey of contending factions.

Living in an arid region where vegetation was of the scantiest, the Libyans were nomadic, as are their modern representatives, and the few representations of them which exist in their deserts are largely scenes of hunting or of cattle. Routes followed by caravans, then as now, ran north and south rather than east and west, and even in early times the Libyans were in connection with the Sudan to the southward, and received the produce of that region, doubtless by means of ox-transport until the camel was introduced.

The Egyptian records are closely discussed in order to derive a clear idea of the social development of the early Libyans, and while holding that they were regularly and extensively polygamous, the author contests the charge of promiscuity which classical writers have brought against them. Their dress, and their material culture and art, is fully described and illustrated, so that the meagre records of these primitive people are made to furnish a fairly adequate picture of the state of civilisation at which they arrived. Their possessions were few and of a simple type, as is to be anticipated among a nomad people, and metals were rare, stone implements being principally used in their arrows, javelins, etc.

A careful summary of their history, drawn from all available sources, completes a most valuable monograph for which the material has been largely collected by the author in the field, and thereby it has gained a reality and a truthfulness of colour to which a compilation can never attain. In an appendix Mr. Bates refers to the so-called "C group, Middle Nubians," of Dr. Reisner in the Nile Valley, and these he would class as a Libyan race which established itself there. Besides furnishing the anthropologist and the geographer with valuable data for their studies, the author by his careful treatment of place-names, has put at the cartographer's disposal material for improving existing maps of North Africa, and the map included in the volume might with advantage have utilised the information so given. H. G. L.

COLLECTED ADDRESSES ON HORTICULTURE.

The Horticultural Record. Compiled by Reginald Cory. Pp. xv + 500 + cxvi coloured plates + half-tone photographs. (London: J. and A. Churchill, 1914.) Price 42*s.* net.

THIS sumptuous volume very ably fulfils the intention of its author as set forth in his preface. For it forms a very complete record of the sayings and doings of the International Horticultural Exhibition, which was held in London two years ago. In it are contained the addresses, and much of the consequent discussions, which dealt with aspects and phases of horticulture in many and varied directions These contributions possess a permanent value, and Mr. Cory would have deserved well of everyone interested in horticulture had he done nothing more than bring these results of the exhibition together in a guise far removed from the formal and often rather repellent character commonly encountered in ordinary official publications. But he has done very much more, and the beautiful illustrations, both coloured and plain, not only add enormously to the attractiveness of the volume, but they give it a value which is permanent, and will secure for it a high place in the historical literature of the garden.

The names of those who were responsible for the main addresses provide a full and sufficient guarantee as to their authoritative character, and the addresses themselves may well be read, and re-read, by those who are interested in the particular departments with which they severally deal.

The International Exhibition succeeded in achieving much more than the mere display of concrete results of horticulture. It served as the opportunity for raising issues of great and widespread interest and importance. The legislative enactments connected with plant diseases, the problems involved in horticultural education, and other subjects, perhaps more directly horticultural were ably and fully discussed, and we have already begun to reap some of the harvest which was sown at Chelsea in 1912.

Too often, perhaps, the results which accrue from congresses of various kinds are altogether incommensurate with the amount of energy and material expended at the meetings, but this is not true of the one now under consideration. It is fitting then that the record should be a full one, and that it should be presented to the world in an attractive form. The author and the publisher have discharged their respective offices with skill, and we do not hesitate to express the opinion that the book is destined to occupy a high place in the literature of horticulture.

OUR BOOKSHELF.

On the Effects of Volcanic Action in the Production of Epidemic Diseases in the Animal and in the Vegetable Creation, and in the Production of Hurricanes and Abnormal Atmospherical Vicissitudes. By Dr. H. J. Johnston-Lavis. Pp. xii + 67. (London: John Bale, Sons and Danielsson, Ltd., 1914.) Price 3*s.* net.

A FEW years ago the Royal College of Physicians of Edinburgh offered their Parkin prize for an essay with the above title, and they were fortunate in being able to award it to the late Dr. Johnston-Lavis, than whom no one could be found more competent to deal with the subject. Johnston-Lavis combined with his well-known familiarity with volcanic phenomena the experience gathered during many years of medical practice, in districts constantly subject to volcanic and earthquake paroxysms.

After giving a general account of the physical and chemical phenomena exhibited during a volcanic eruption, the author proceeds to detail and examine the exaggerated and often grotesque accounts given by many authorities concerning the terrible diseases that have affected human beings, and also animals and plants, during and subsequent to volcanic outbursts. Dr. Johnston-Lavis's general conclusions, after an examination of the whole question, are that while there is no *direct* relations between volcanic phenomena and disease, there are the following *indirect* ways in which epidemic disease may be caused or increased during or after volcanic eruptions:—

(1) The irritating and depressing effects of poisonous fumes on the eyes and throat.

(2) The disturbance of water-courses, leading to wells and surface supplies being infected from sewage; and the interference of the ventilation of houses by the accumulation of ejected materials.

(3) The moral depression from fear, with the hunger resulting from food-supplies being cut off, these causes being now recognised as rendering living beings less immune to infection.

That great atmospheric disturbances are occasioned by volcanic outbursts is admitted by all meteorologists.

Praktikum der Chemischen, Biologischen und Bakteriologischen Wasseruntersuchung. By Prof. O. Emmerling. Pp. vii + 200. (Berlin: Gebrüder Borntraeger, 1914.) Price 7.20 marks.

As indicated in the title, this work consists mainly of a series of descriptions of the methods employed in the examination of waters. As is well known, the chemical methods employed in German practice differ in some respects from those in vogue here, and it is therefore interesting to be able to institute a comparison. Although several methods are frequently described for a particular estimation, little advice is given as to which is the best to employ, and occasionally insufficient attention is paid to the fact that very small amounts have to be estimated.

A sign of the times is the inclusion of methods for the estimation of the radioactivity of mineral waters. A considerable amount of attention is paid to the biological, as distinguished from the bacteriological, examination, and a large number of excellent figures are given of the various species of organisms likely to be met with in waters of various types.

The least satisfactory section is that dealing with the bacteriological examination of water. In particular, the detection and enumeration of the *B. coli communis,* to which so much attention is paid in this country, is treated in an extremely inadequate manner.

Highways and Byways in Lincolnshire. By W. F. Rawnsley. With illustrations by F. L. Griggs. Pp. xx + 519. (London: Macmillan and Co., Ltd., 1914.) Price 5*s.* net.

THIS book maintains the high reputation of the series to which it belongs. Mr. Rawnsley has throughout supposed the tourist to be travelling by motor, and has accordingly said very little about footpaths. Lincolnshire, he says, teems with splendid churches, and that is the first impression received after looking at the admirable illustrations which Mr. Griggs has provided. But attention is by no means confined to ecclesiastical architecture, for the book abounds in anecdotes, gossip, and quaint information. We read that Sir John Franklin, the famous arctic navigator, and Major James Franklin, who made the first military survey of India, were born at Spilsby in this county. On the road from Spalding to King's Lynn the author tells us he passed a field with an unfamiliar crop of stiff purplish plants which showed where the cultivation of *Isatis tinctoria,* the woad plant, which added so much to the attractiveness of our earliest British ancestors, was still kept going. Or, again, at Tothby a plague-stone is to be found, and we are given a bright account of how sufferers from the plague in the seventeenth century were fed without spreading infection. The book will appeal not only to Lincolnshire people, but also to all who love the English countryside.

Les Coordonnés intrinsèques. Théorie et Applications. By Dr. L. Braude. (*Scientia,* No. 37.) Paris: Gauthier-Villars, 1914. Pp. 100. Price 2 francs.

ALTHOUGH quite good in its way, this book does not present any very striking features. It may best be described as a collection of problems most of which could be worked out as exercises by any fairly good English mathematical student. Intrinsic equations are here obtained for the usual well-known plane curves, such as cycloid, catenary, equiangular, spiral, and they are applied to the study of associated loci such as roulettes, Mannheim's curves, pedals, or involutes and evolutes. In England this work is commonly studied in courses rightly or wrongly described as "advanced calculus," but it may be useful to teachers and others to have a book of reference in which the subject is treated separately and in greater detail than in our calculus text-books.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Accumulated Rainfall at Excessive Rates.

IN the *Monthly Weather Review* a table (No. II.) is regularly published giving accumulated amounts of precipitation when the rates equal or exceed:—

Duration	5	10	20	30	60 minutes.
Rate per hour	3·00	1·80	1·20	1·00	0·80 inches.

Unfortunately the headings and the entries are not consistent; and the purpose of the table is defeated by a tabular arrangement in which sense is sacrificed for space. The table misleads American meteorologists, even those of us familiar with the arrangement; and it is therefore not to be wondered at that the most eminent of climatologists, Dr. Julius v. Hann, read for a five-minute interval 4·19 in. of rain when the actual fall was 0·13 in. at Oklahoma, June 30, 1913 (*M.W.R.*, 41·7: 1129, July, 1913).

Prof. Hann directed attention in the *Meteor. Zeitschrift,* of which he is editor, to this remarkable rate (*Meteor. Zeits.*, vol. xxxi., part 4, p. 196), stating that it was the heaviest rainfall on record, and gravely adding that the rate, 21·3 mm. was most remarkable, and that it was scarcely conceivable that so much water could fall from the sky in five minutes.

Dr. Hann should not be held responsible for the error. A correction has been published in a recent number of the review, but few will see it, and in the confusion incident to the war it may escape general notice. We are likely, therefore, to meet the statement in years to come that official records show a rainfall of the rate given above.

With the hope of preventing future misunderstandings, I have appealed to the chief of the Weather Bureau to alter the table, and have further urged that now is an opportune time to abandon the use of inches in measurements of precipitation and use the millimetre. Is it not also high time that British rainfall was expressed, if not indeed measured, in millimetres?

Accumulated amounts at excessive rates are of interest to engineers, and it might be well to substitute for the present values, which are arbitrary and confusing, the following rational units:—

Duration ...	1	5	10	60 minutes.
Rate per hour ...	1	5	10	20 mm.

I add the heaviest known rainfalls and rates with the hope that some of the readers of NATURE will amend.

	Rate per hour	Actual duration of rate
Baguio, P.I., July 14, 1911 ...	49 mm.	24 hours
Campo, Cal., August 12, 1891 ...	219 „	80 minutes
Guinea, Va., August 24, 1906 ...	470 „	30 „
Curtea de Argrea (Roumania), July 7, 1889	615 „	20 „

ALEXANDER MCADIE.

Blue Hill Observatory, October 12.

Fizeau's Experiment and the Principle of Relativity.

SIR JOSEPH LARMOR has kindly pointed out to me that it is incorrect, in the interpretation of Fizeau's experiment, to assume that the velocity of propagation of light is the group velocity, so that I must withdraw the conclusion drawn by me in NATURE of October 22, that Michelson and Morley's repetition of the experiment, when correctly interpreted, is in close agreement with the predictions of the principle of relativity. This being so, it may be worth while to direct attention to certain facts in connection with that experiment which render it quite inconclusive.

(1) On the ground of an experimental device for estimating the pressure gradient at different points of the tube, Michelson and Morley assume that the velocity along the axis is equal to 1·165 times the mean velocity. This is in sharp contradiction with the theory of the flow of liquid in a tube which shows that the axial velocity is twice the mean.

(2) The beam of light which traverses the tubes appears from the figures given to occupy a considerable fraction of the whole area of the tube, and is thus subject to a retardation in phase which varies with the variation of the velocity of the liquid at different distances from the axes. It may be shown that the retardation in phase of the resultant disturbance when brought to a focus is equal to that which would be produced if the velocity of flow were uniform and equal to the mean velocity over the part of the tube occupied. If this were the whole tube the result of applying these corrections would be to increase the result given by Michelson and Morley for the convection coefficient from 0·434 to 0·515. On the other hand, if the diameter of the beam were about 0·93 of the diameter of the tube the mean velocity would be so much greater that the convection-coefficient would be reduced to the theoretical value given by the formula of Lorentz, viz., 0·451. There is thus a possibility of general agreement, but the experiment is quite indecisive.

The announcement that Prof. Zeeman has repeated the experiments with great care and with monochromatic light and has succeeded in observing a dispersive effect is, therefore, of great importance, and his detailed results will be awaited with much interest (Amsterdam Proceedings, September 26).

E. CUNNINGHAM.

St. John's College, Cambridge, October 26.

Flint Fracture.

MR. LEWIS ABBOTT's letter in NATURE of October 22 is almost entirely irrelevant to the subject of my communication to NATURE of September 24. In this note I dealt solely with one form of flint fracture, viz., the large, flat, non-conchoidal fractures, surfaces which are produced by a certain type of "cleaving" blow, and pointed out how it is possible to determine the nature and direction of the fracturing-agent by the recognition of the fissures of varying size radiating from the point of impact. Mr. Abbott, however, states, these "are certainly not fissures"; but an examination of these markings upon a flint and a reference to the meaning of the word "fissure" in a dictionary will convince anyone that my description is correct.

The major part of Mr. Abbott's letter deals with subjects upon which my former note has no bearing, and though I agree that these are important and need investigation, yet it seems regrettable, if the problems they present were, as Mr. Abbott infers, in process of solution several years ago, that the knowledge already acquired at that time has not up to the present been laid before the scientific world. It is to be hoped that Mr. Abbott may be able to induce the collector who interviewed the late Sir John Evans to do so without delay.

J. REID MOIR.

12 St. Edmund's Road, Ipswich, October 23.

TOWARDS NATURE-STUDY.[1]

(1) PROF. ABBOTT'S aim is to give "a simple statement of the fundamentals of General Biology," both for the general reader and the laboratory student. He deals with both plants and animals, shifting his field so as to get the best illustrations. The main subjects discussed are—living substance, the primary functions, metabolism, growth, differentiation, development, variation and heredity, organic response, species and their origin. The book is well-illustrated and marked by three other qualities—an admirable clearness which points to teaching experience, a pleasant freshness of treatment which is in part due to the numerous references to recent work, and an all-roundness of survey, for almost every aspect of biology is at any rate recognised and illustrated. This third quality lays the book open to the disadvantage of sometimes saying too little, but most introductory books of this sort say far too much. But we should have liked, for instance, to know more about those sea birds which "lay their eggs on the bare rocks and pay no more attention to them thereafter."

(2) Prof. J. R. Ainsworth-Davis is a firm believer in the value of "nature-study" as a factor in increasing efficiency, and his book—an outcome of large experience—is meant to indicate how the subject may be best dealt with, especially in country schools. After clearly indicating how arithmetic, for instance, may be made vital in the country schools by being applied to actual problems, he proceeds to show this is even more essential in connection with nature-study. For this reason the book gives prominence to common plants and animals and familiar physical phenomena. In regard to the part dealing with plants and animals, however, it appears to us that the author falls far short of his counsel, telling too much and suggesting too little. It is good pemmican, but it is pemmican. In his introduction he protests against the "informational obsession," and upholds "the educational ideal";

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[1] (1) "The Elementary Principles of General Biology." By Prof. J. F. Abbott. Pp. xvi+329. (New York: The Macmillan Co. London: Macmillan and Co., Ltd. 1914.) Price 6*s*. 6*d*.

(2) "The Pursuit of Natural Knowledge." By Prof. J. R. Ainsworth-Davis. Pp. iv.+234. (Cheltenham: Norman, Sawyer and Co., Ltd., 1914.) Price 1*s*. net.

(3) "Animal Life by the Sea-shore. By Drs. G. A. and C. L. Boulenger. Pp. xii+83+plates. (London: Offices of *Country Life, Ltd.*, n.d.) Price 5*s*. net.

(4) "The Naturalist at the Sea-shore." By R. Elmhirst. Pp. viii+86+8 plates. (London: A. and C. Black, 1913.) Price 1*s* 6*d*. net.

(5) "Bird Studies in Twenty-four Lessons." By W. P. Westell. Pp. xii+152. (Cambridge: University Press, 1914.) Price 2*s* 6*d*. net.

(6) "Common British Beetles." By Rev. C. A. Hall. Pp. vii+86. (London: A. and C. Black, 1914.) Price 1*s*. 6*d*. net.

(7) "Odd Hours with Nature." By Alexander Urquhart. Pp. 323+plates. (London: T. Fisher Unwin, n.d.) Price 5*s*. net.

(8) Ernst Haeckel: "Die Natur als Künstlerin." Nebst: Dr. W. Breitenbach; "Formenschatz der Schöpfung." Pp. 114. (Berlin: Ch. Vita, Deutsches Verlaghaus, n.d.)

(9) "A Natural History of Bournemouth and District," including Archæology, Topography, Municipal Government, Climate, Education, Fauna, Flora and Geology. By the Members of the Bournemouth Natural Science Society. Edited by Sir Daniel Morris. Pp. xiv−400. (Bournemouth: Natural Science Society, 1914.) Price 2*s*. 6*d*. net.

(10) "Handbuch der naturgeschichtlichen Technik für Lehrer und Studierende der Naturwissenschaften." Herausgegeben von Prof. Bastian Schmid. Pp. viii+555. (Leipzig and Berlin: B. G. Teubner, 1914.) Price 15 marks.

(11) "Biologen-Kalender." Edited by Prof. B. Schmid und Dr. C. Thesing. Erster Jahrgang. Pp. ix+513. (Leipzig and Berlin: B. G. Teubner, 1914). Price 7 marks.

but it seems to us that in the bulk of the book the author is informational with the best of them. But Prof. Ainsworth-Davis knows his own business, and while we do not think that his method (as regards living creatures) is the best, he has chosen it deliberately. We hasten, therefore, to say that he has produced a wonderful little book, clear, terse, and accurate, which will aid in their pursuit of natural knowledge those who combine good intellectual digestion with the inclination and opportunity to verify what they are told.

(3) It is interesting to find Drs. Boulenger, father and son, uniting their abilities and enthusiasm in the production of a guide to the study of the animal life of the seashore. The result is a delightful and effective book by which those interested can identify many of the littoral animals and get some trustworthy information about them. We confess to being surprised at the suggestion in the preface that there was a lack of a book of this kind, for Dr. Marion Newbigin's "Life by the Seashore" is an excellent and trustworthy guide, and Sinel's is also good. But there is no risk of exhausting the interest of the shore, and the book before us has a character of its own and pre-eminence in the excellence of its photographic illustrations, many of which are fascinatingly beautiful. That of the sea-horse (Fig. 1) is a good instance.

The authors tell their story in a clear and interesting way, which stimulates both observation and reflection. We read of the wrasses sleeping on one side, of the stickleback's nest and large eggs, of the sting of the weever, of paternal care among pipe-fishes, of the homing of limpets, of the boring of piddocks, of the shrivelling of the lobster's muscles before moulting, of the colour-change in *Hippolyte varians,* of the various seashore insects, of the cotton-spinner's sticky thread-like tubes, of the partnership between hermit-crabs and anemones, and of much more that makes us long to be back to the shore again.

(4) Another shore-book, to be strongly recommended, has been written by Mr. Elmhirst, superintendent of the Marine Biological Station at Millport. It is the work of an experienced naturalist who has written simply and clearly about what he knows well. He begins with the common seaweeds and works up to the shore-birds, and by exercising a wise restraint has succeeded in giving a luminous, not over-crowded, picture of the natural history of the shore. He has many interesting notes on the habits of animals, telling us, for instance, of the way in which *Echinus miliaris* dresses itself up till it becomes "a sort of moving scrap-heap," of the shrimp's rapid burying of itself, of the sea-spider (Pycnogonum) sticking its proboscis into an anemone and sucking up the juices through a filter, of the dog-whelk boring through a mussel, and of the starfish slowly forcing the same bivalve to gape. There are some very effective photographs, but the most striking feature of the book is to be found in the charming coloured pictures by Mr. William Smith. It seems to us very unpractical to put one of these beautiful sketches on the cover. If it is put there it should also be repeated inside the book.

(5) Mr. Westell believes in "a very real desire for a school-book on birds," and he has suggested twenty-four practical out-of-door studies, which he has wisely arranged in the order of the seasons. The "lessons" are conversational and socratic, and they suffer a little from the defects of these qualities. The conversation is occasionally thin, and the questions are sometimes fatiguing. But there is a pleasant temper in the book and a feeling of the open-air. The children who answer all the problems set—some of them very educative—will certainly know a lot about birds. We think that the author should have taken more care with his English—especially in a book intended for schools. Thus we read: "One of the most remarkable episodes connected with the life-story of these aquatic birds is the provision which has been made for the young to be able to take care of themselves as soon as they are born." As the starling "hawks and hovers in the air," etc., "it presents a fine study of a familiar bird which adds a good deal of charm to the bird life near at

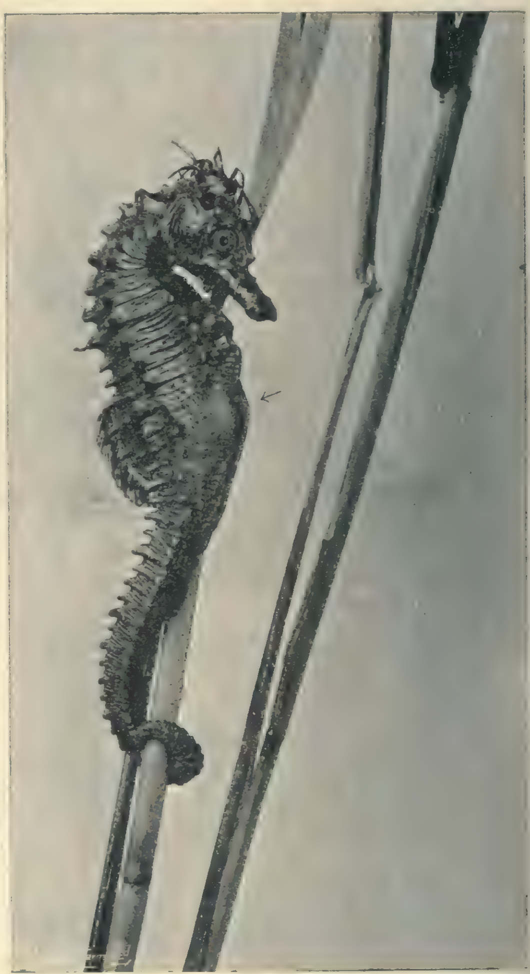

FIG. 1.—Sea-horse. From "Animal Life by the Sea-shore."

home." It is a pity that there are many of these awkwardnesses in this little book. But the book is well-conceived and on the whole sound. It is very effectively illustrated, and the multiple appendix, mostly devoted to practical matters, from observational outfit to the Wild Birds' Protection Acts, will be found exceedingly useful.

(6) Mr. Hall has provided a useful introduction to the study of British beetles—a study which only needs to be begun seriously to become an enthusiasm. The book has an introductory chapter describing the external structure of beetles, and another on their habits, as illustrated by the Green Tiger beetle, the large water-beetle, the burying beetles, the cockchafer, and so on. Apart from some hints on collecting and mounting, the rest of the book is devoted to terse descriptions of some of the commoner forms. These descriptions are quite effective, but we should like to have had more information in regard to habits. The coloured plates, which are on the whole very successful, will be of great service in identification. It seems to us very unpractical to put one of the plates on the cover. There are some interesting photographs, but that of the trachea of Dytiscus does not show the structure as it professes to do. We wish the book success.

(7) There is an intellectual discipline in nature study and the possibility of learning certain lessons which are for our good as citizens of the world, but perhaps the surest gain is simply an increase in our love for the country. If nature study does not lead towards this, there is something wrong. Holding this view, we have always a welcome for a book like Mr. Urquhart's "Odd Hours with Nature," which was evidently written with joy and sincerity. The author takes us with him on his every week walks, and we enjoy his company as he shows us the tree-creeper in the winter-woods, the supernumeraries (bachelors and widows?) of the rookery, the field where the hares fight, the trickery of the lapwing, the trustfulness of the young deer, the dipper walking on the bottom of the stream, and so on till we come back to a queen humble-bee disturbed in her winter retreat. There is nothing very profound in the author's studies, but they are the fruits of observation and reflection, written in excellent style, expressing a love of nature and contributing to its diffusion. We give an example (Fig. 2) of the well-chosen illustrations with which the studies are adorned.

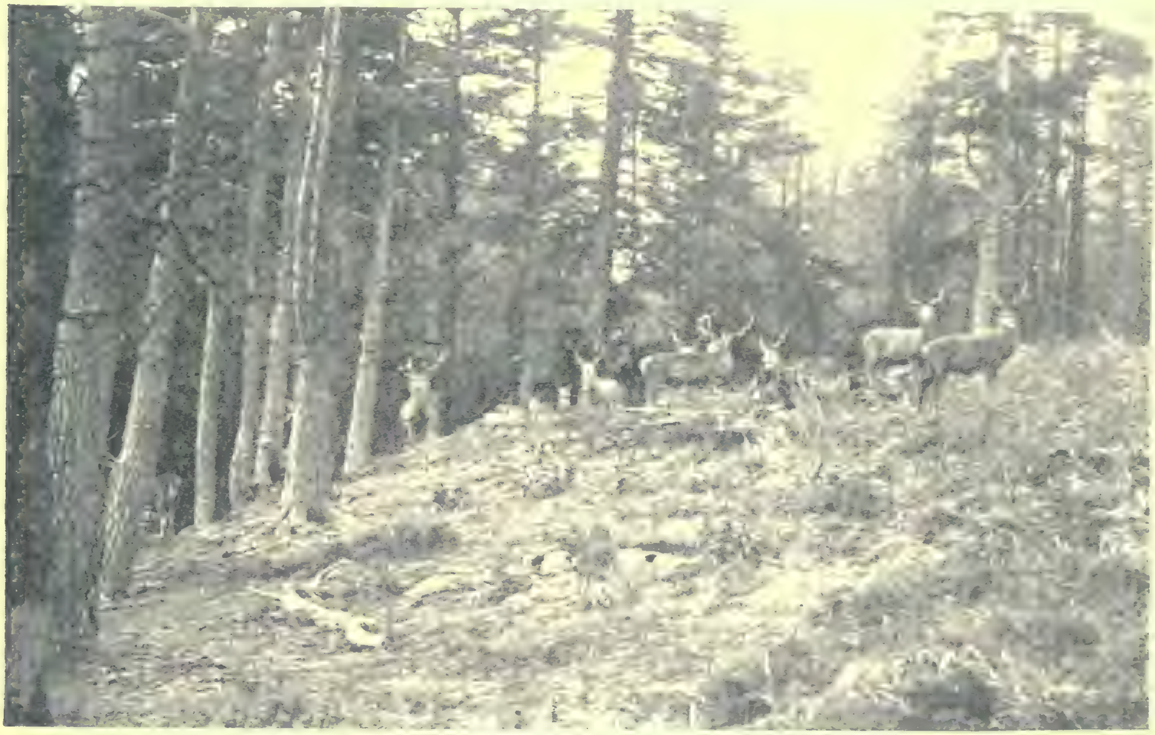

FIG. 2.—[illegible] Stags [illegible] From "Odd Hours with Nature."

(8) It is said that many people have been led by the pathway of photography to an appreciation of the beauty of the world, and the book of striking photographs of natural objects which has been published by the director of the "Urania" institute in Berlin should prove effective in this direction. It is a scientific picture-book, displaying some of the most beautiful objects in the world, many of which will be new and startling to most people. The album illustrates the exuberant decorativeness of Haeckel's Radiolarians, Medusæ, and Siphonophores; the gracefulness of Allman's zoophytes; the futurism of Lehmann's fluid crystals; the fascinating

beauty of calla-lilies, heaths, poppies, and ferns; the likeness between frost-flowers on the window-pane and the snow-laden forest-trees; the flower-like corals; the individuality of shells; the exquisiteness of hidden organic architecture; the conscious beauty of Argus pheasant and bird of paradise; and much more besides. Who is sufficient for all these things? The pages are too crowded to do full justice to the various pictures, the table of the beauty-feast is overloaded, but no one can fail to get an impression of subtle and exuberant beauty. The text accompanying the album consists of two essays. The first is by Haeckel, entitled, "Nature as Artist," and in it the veteran expounds his theory of a "plastic instinct" in protoplasm. Every organic product arises in accordance with physical and chemical laws, but it is none the less an expression of the "cell-soul." Many naturalists have said the same thing in different words! The second essay is by Dr. W. Breitenbach and deals with the universality of beauty in nature, its manifold expression, and the enrichment of human life which it may afford.

(9) We have nothing but praise for the Regional Survey which has been compiled and published by the Bournemouth Natural Science Society under the able editorship of Sir Daniel Morris. It is a model of what such a book should be—dealing with the topography, geology, zoology, and botany of the district, and not forgetting the works of man, both past and present. The society is to be congratulated on having so many members able to co-operate competently in a work of this kind; and those who have the good fortune to reside in an area with so many interesting features are to be congratulated on the possession of this excellent aid to a fuller appreciation of their opportunities.

(10) Prof. Bastian Schmid has done a useful piece of work in compiling a manual on the technique of natural science, and he deserves our thanks. The book had, of course, to be written co-operatively, for only experts could deal effectively with the great variety of technical methods now in use in nature study in the wide sense. Prof. H. Poll deals with zoological microscopy, Dr. H. Fischer with botanical microscopy, including bacteriological and mycological methods, Prof. P. Claussen with experiments in vegetable physiology, Prof. R. Rosemann with methods in animal physiology, Dr. C. Wagler with hydrobiology, Dr. O. Steche with collecting and preserving insects, Dr. Paul Kammerer with collecting molluscs and vertebrates, Prof. Schoeler with herbaria, Prof. B. Wandolleck with preserving animals and setting them up, Prof. F. Urban with vivaria, Dr. P. Esser with school-gardens, Dr. H. Fischer with the microscope, Prof. B. Wandolleck with photography, Prof. R. Fricke with excursions, the editor with practical arrangements and devices in schools and colleges, Dr. A. Berg with geological school-collections, and Prof. Bock with the care and appreciation of what is beautiful and instructive in open nature. The result of this collaboration is a very remarkable and valuable book which ought to be utilised by those teachers of natural science who wish to make their instruction more effective. Where we have been able to test the work, we have found it to be altogether to the point—detailed, precise, and up to date.

(11) Drs. B. Schmid and C. Thesing have made a brave attempt to combine a Who's Who in Biology, a directory of institutes, gardens, and technicians, an obituary, a list of the most important recent biological publications, and a number of short essays dealing with present-day problems. It is the first issue, and we sympathise with the editorial appeal for suggestions rather than criticisms. We would suggest that the editors should re-cast their net. A list of contemporary biologists which omits Bateson, Delage, Wilson (to take an instance from each of three countries), obviously requires revision, and the same remark applies to the pages devoted to the almost impossible task of giving a list of the most important publications. The bibliographies of the works of not a few of the biologists are much in need of pruning: others, such as Sir Ray Lankester's, are as much in need of being brought nearer completeness. The introductory essays on bird-marking, symbiosis, phenology, natural science in schools, problems of modern zoology, microscopic technique, and the like are admirable. As the calendar makes for co-ordination, we wish it success.

THE TOTAL SOLAR ECLIPSE OF AUGUST 21, 1914.

(1) THE ROYAL OBSERVATORY ECLIPSE EXPEDITION TO MINSK, RUSSIA.

THE programme of observations of the Royal Observatory Eclipse Expedition to Minsk, Russia, was in the main the same as that planned for the Brazilian eclipse in 1912, but which rain had prevented from being carried out. The instruments comprised: (1) the Thompson coronagraph, consisting of a lens of 9 in. aperture and of 8 ft. 6 in. focal length, in conjunction with a Dallmeyer negative enlarger, giving an equivalent focal length of 36 ft., for the purpose of taking large-scale photographs of the corona, on a scale of 4 in. to the sun's diameter. (2) Two telescopes of 6 in. aperture, and of focal lengths 2 ft. 3 in., and 6 ft. 6 in. respectively, used in conjunction with green colour filters (Wratten and Wainwright's mercury monochromat), which let through a band in the green in the region of the coronium line λ 5303, the object of these being to obtain evidence as to the presence and distribution of coronium in the corona. In order to disperse such continuous light from the corona as the filter transmitted, a prism was placed before each object glass. (3) The Hills' quartz spectrograph for obtaining the ultra-violet spectrum of the flash and of the corona. For (1) and (2) 16 in. cœlostats were used, and for (3) a cœlostat with a 9-in. speculum mirror, in combination with a speculum condensing mirror. Provision was also made for obtaining iron arc and solar comparison spectra, for the accurate determination of the wave-lengths.

The expedition was fortunate in having an unobscured view of the eclipse during the whole period of totality, there being much cloud in the sky at the time, and the returning crescent being hidden immediately afterwards. In the town of Minsk, three miles away, practically nothing was seen of totality. Thus the whole programme of observations was carried through.

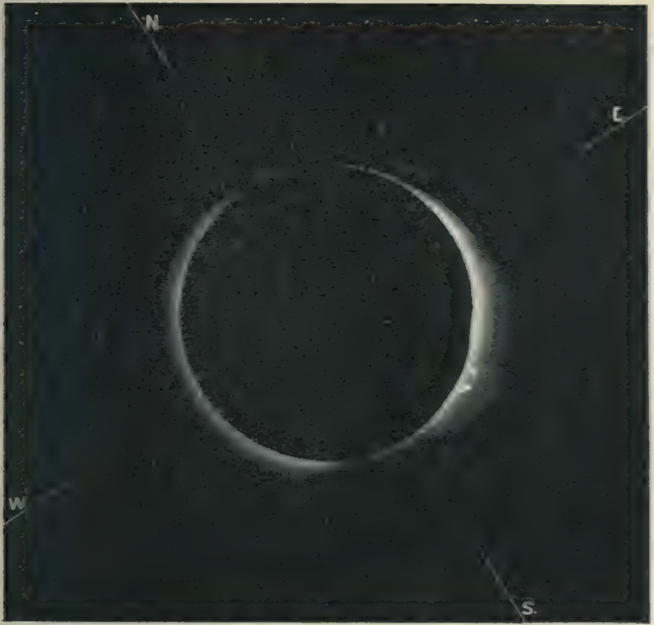

Fig. 1.—Corona, 2-4 sec., Ilford Process Plate.

To the eye, the corona appeared bright and of a steely-blue whiteness, and during totality the darkness was not very intense. Regulus could be seen shining through the corona, and Mercury and Venus were also visible. The corona was of the intermediate type, with four streamers, and resembling somewhat the 1898 corona. A sheet was spread for the observation of shadow bands, but none were observed. The temperature readings taken during the eclipse show that the shade temperature fell 5·5° F., but the humidity was not affected.

With the coronagraph seven photographs were taken, with exposures varying from 2 to 25 secs., on Ilford Process, Empress, and Special Rapid plates. These show a large prominence on the limb of the sun near the point of second contact, about one-twentieth of the sun's diameter in height. In the neighbourhood of this prominence the corona shows some interesting detail in the form of coronal arches. There was also a smaller prominence on the other limb of the sun. The shape and structure of the present corona is interesting as compared with the records of past coronas, inasmuch as it is of a type which has not been previously studied, viz., that belonging to the sun when near minimum, but with an increasing spot-activity. Fig. 1 shows the corona, near the commencement of totality, photographed on a Process plate with an exposure of 2 seconds, and developed with pyro-soda. Fig. 2 shows it near the end of totality, the exposure being 5 seconds on an Empress plate, developed with methol-quinol.

With each of the telescopes with the colour filters four exposures were made, of 25, 40, 40, and 25 secs. respectively, the refracting edges of the prisms being vertical for the first two and horizontal for the second two exposures. For the purpose of changing from one position to the other, the telescopes had been mounted so that their axes could move upon the surface of a right circular cone the axis of which was in the direction of the beam reflected from the cœlostat. The presence of coronium in the corona should be indicated on the photographs by a sharp ring superposed upon a fainter background due to the dispersed continuous light. The photographs taken enable us to assert that any results obtained without the use of prisms would have been of no value and liable to misinterpretation. Beyond that their evidence is negative. No trace of coronium light is apparent, and, in the absence of other evidence, it must be concluded that coronium as indicated by the green line was almost entirely absent from the present corona.

The photographs taken with the spectrograph are good, though not quite so successful as had been hoped for. More cannot be said about these until they have been carefully measured.

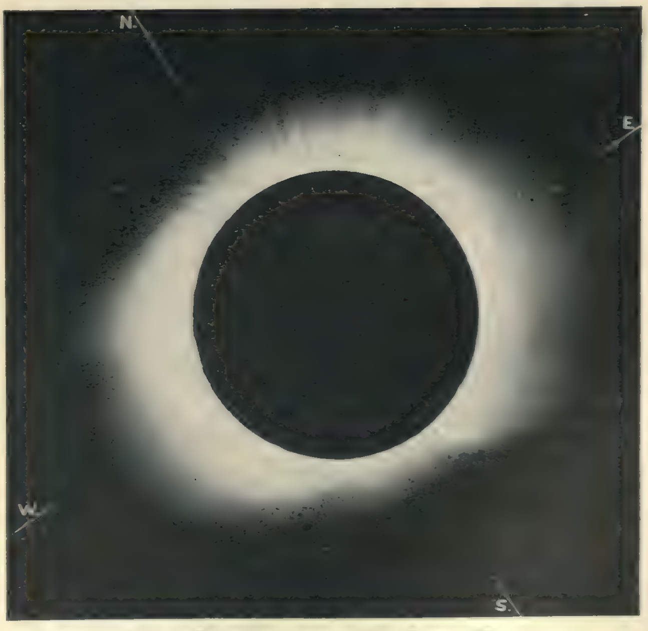

Fig. 2.—Corona, 112-117 sec., Ilford Empress Plate.

H. S. Jones.
C. R. Davidson.

(2) THE AMHERST ECLIPSE EXPEDITION TO RUSSIA.

Although the Imperial Academy of Science at the instance of Dr. Backlund, together with the Government railways, had offered every facility in transportation of observers and instruments, the necessity of immediate mobilisation had made it impossible to deliver my cases in Kieff at the expected time. Many days of patient waiting there had convinced me that it was best to prepare if possible an entirely new set. With the help of Mr. Day, a 6 in. Dallmeyer portrait lens was found in a photographer's *atelier* in the Krestchatik; at the University shop, Prof. De Metz had a long tube and shutter made, which, with a new Dresden camera and plate-holders, provided an adequate outfit—everything except clockwork motion. It was necessary, therefore, to use the tube as a stationary camera, and plates as sensitive as possible so that the diurnal motion should not blur the coronal filaments. Fortunately we put the apparatus together in time and in working order at Kieff, and with the help of Prof. Sleusarefsky found the exact focus, so that little remained to do at the station but set the camera rigidly in exact alignment towards the sun at mid-totality and make the necessary practice drill.

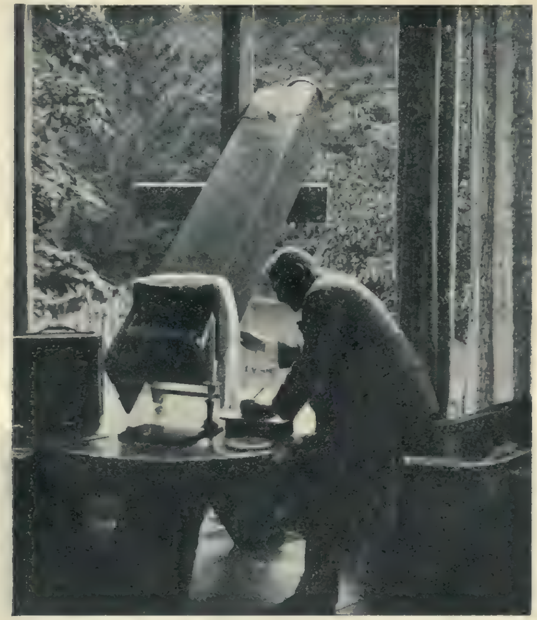

FIG. 1. Prof. David Todd with the camera contrived for the photography of the solar corona during the eclipse on August 21, 1914.

By invitation of Count Bobrinsky, whose estates are in Smala, about 100 miles south-east of Kieff, I was several days his guest, and had abundant opportunity, while enjoying the hospitality also of Prince Trubetskoy, to mount the camera very satisfactorily. The illustration (Fig. 1) shows the instrument in position on the portico of Count Bobrinsky's residence.

Smala proved to be exactly in the line of central eclipse, and certainly no one could have had a better position than in the midst of this superb estate. During totality the sky was shrouded in thinner clouds than elsewhere in Central Russia; so that of the six exposures on Moscow plates, from a half-second to two seconds in length, four of them turned out better than I had expected from the drifting clouds which had in no instance permitted the corona to be seen entire. Two of the four will afford detailed estimates of the light of the inner corona. Star-trails on the plates were made by α Ophiuchi on two nights after the eclipse. As the camera had remained unmoved since totality, the direction of the "parallel" gives exact location of the prominences and coronal details. Both corona and star trail were, of course, developed together on the same plate.

I have pleasure in acknowledging much assistance from Mr. Gubtschefsky, president of the Society of Photographers in Kieff.

DAVID TODD.

THE BRITISH ASSOCIATION IN AUSTRALIA.

MANY of those who made up the "Overseas Party" of the British Association at the recent Australian meeting have now returned home. In a former article it has been stated that some members found it necessary, after the Orient liner *Orvieto* was requisitioned by the Commonwealth Government, to return a week earlier by the P. and O. vessel *Malwa*, which they were only able to catch at Adelaide by leaving Sydney the day before the conclusion of the meeting there; the number of those who did this was twenty-six. The steamer *Demosthenes*, leaving Australia earlier still, *viâ* South Africa, carried a few members. The following P. and O. ship, the *Morea*, a fortnight later than the *Malwa*, carried a party of more than sixty, who were in England by October 16 after a voyage favoured by beautiful weather—as, it may be added, the meeting had been.

Some forty members proceeded northward from Brisbane after the conclusion of the meeting by the Burns, Philp steamer *Montoro* for Singapore; she was reported to have arrived there safely on September 26, so that her passengers may now be nearing home. Of a number who left from Sydney to follow the Trans-American route, some are home already. Others, however, intended to visit New Zealand, in spite of the cancellation of the arrangements which had been made in that Dominion to hold a scientific meeting there. Those who had it in mind to make a stay in New Zealand if possible, either immediately after the Australian meeting or later, numbered not fewer than fifty. The official excursion to Tasmania after the meeting attracted a dozen members or more. A large number whose plans were unaffected by the European situation were carrying out their programmes for a prolonged stay in Australia or elsewhere. The next P. and O.

ship, the *Maloja,* which is due about October 30, should bring a party.

In justice to the Australian Commonwealth and States and the official and unofficial hosts in Australia, to whom the visiting members of the British Association are so deeply indebted, it cannot be stated too clearly that the European crisis was allowed in no way to diminish, if it did not actually increase, the warmth of the reception accorded to the party, and that it did not affect the scientific work of the meeting adversely; in fact, its direct effects were scarcely perceptible in any centre. Immediately on landing at Adelaide, at the beginning of the meeting, a number of members of the Council met the principal representatives of the local organisation in order to assure them that the party would readily fall in with any modification of the programme which might be found necessary, but the question had already been carefully considered, and the answer was at once returned that local opinion was unanimous that the scientific work of the meeting should proceed, even though some slight changes might be found desirable in respect of excursions and social functions. Any such changes proved, in the event, to be negligible. A practical demonstration, however, of the visiting members' profound sense of gratitude to Australia was given when the party subscribed the sum of 611*l.* 6*s.* to the patriotic funds being raised there; this subscription was transmitted at the close of the meeting to the Governor-General, and by him divided equally between the funds in the various States.

If the immediate scientific importance of the meeting has been in some measure obscured, it is confidently felt by all concerned that its good effects will be great and lasting, and that they will become apparent in many directions. While it was inevitable that far less news of the meeting than usual should appear in the daily Press at home, the Australian newspapers reported the meetings more fully than could have been expected in the circumstances. Public interest was maintained to the end; sufficient evidence of that is found in the very large number of local members, and it was interesting to observe how, after the daily enrolment of these members had fallen off abruptly on the declaration of war, it recovered and proceeded briskly, after a few days, up to the beginning of the meetings at Melbourne and Sydney.

The organisation of the meeting could scarcely fail to be of profound interest to those who shared in it. Its ramifications were very wide; it involved, for example, negotiations more or less detailed with various departments of seven Governments (those of the Commonwealth and the States), with a dozen transport companies, and with many other public bodies. The work extended over four years, and was continuous both at home and in Australia for a full year before the meeting began. Upwards of a hundred persons were concerned more or less actively in responsible departments of the organisation; the majority of them were, of course, in Australia, and the officers of the Association at home met with nothing but goodwill at the hands of all these willing collaborators, who have the satisfaction of knowing that the mechanism which they called into being worked splendidly, and possessed driving power sufficient to overcome the resistance set up by the unexpected circumstances in which the meeting took place.

Subjoined is a list of the Research Committees, etc., receiving grants of money, and the name of the chairman of each, appointed on behalf of the General Committee at the Australian meeting:—

Section A—Mathematics and Physics.

Seismological observations—Prof. H. H. Turner ...	£60 0 0	
For printing in connection with above	70 0 0	
Investigation of the upper atmosphere—Dr. W. N. Shaw	25 0 0	
Annual tables of constants and numerical data, chemical, physical, and technological—Sir W. Ramsay	40 0 0	
Calculation of mathematical tables—Prof. M. J. M. Hill	30 0 0	
		£225 0 0

Section B—Chemistry.

The study of hydro-aromatic substances—Prof. W. H. Perkin	15 0 0	
Dynamic isomerism—Prof. H. E. Armstrong	40 0 0	
The transformation of aromatic nitroamines and allied substances, and its relation to substitution in benzene derivatives—Prof. F. S. Kipping	20 0 0	
The study of plant enzymes, particularly with relation to oxidation—Mr. A. D. Hall	30 0 0	
Correlation of crystalline form with molecular structure—Prof. W. J. Pope	25 0 0	
Study of solubility phenomena—Prof. H. E. Armstrong...	10 0 0	
Chemical investigation of natural plant products of Victoria—Prof. Orme Masson	50 0 0	
The influence of weather conditions upon the amounts of nitrogen acids in the rainfall and the atmosphere—Prof. Orme Masson ...	40 0 0	
Research on non-aromatic diazonium salts—Dr. F. D. Chattaway	10 0 0	
		£240 0 0

Section C—Geology.

To investigate the erratic blocks of the British Isles, and to take measures for their preservation — Mr. R. H. Tiddeman	5 0 0	
To consider the preparation of a list of characteristic fossils—Prof. P. F. Kendall	10 0 0	

The Old Red Sandstone Rocks of Kiltorcan, Ireland—Prof. Grenville Cole	10 0 0	
Fauna and flora of the Trias of the western midlands—Mr. G. Barrow	10 0 0	
To excavate critical sections in the Lower Palæozoic rocks of England and Wales—Prof. W. W. Watts ...	15 0 0	
		£50 0 0

Section D—Zoology.

To investigate the biological problems incidental to the Belmullet Whaling Station—Dr. A. E. Shipley ...	45 0 0	
Nomenclator animalium genera et subgenera—Dr. Chalmers Mitchell	25 0 0	
An investigation of the biology of the Abrilhos Islands and the north-west coast of Australia (north of Shark's Bay to Broome), with particular reference to the marine fauna—Prof. W. A. Herdman	40 0 0	
To obtain, as nearly as possible, a representative collection of marsupials for work upon (*a*) the reproductive apparatus and development, (*b*) the brain—Prof. A. Dendy	100 0 0	
		£210 0 0

Section E—Geography.

To investigate the conditions determining the selection of sites and names for towns, with special reference to Australia—Sir C. P. Lucas	20 0 0	
The hydrographical survey of Stor Fjord, Spitsbergen, by Dr. W. S. Bruce—Mr. G. G. Chisholm	50 0 0	
To aid in the preparation of a bathymetrical chart of the Southern Ocean between Australia and Antarctica—Prof. T. W. Edgeworth David	100 0 0	
		£170 0 0

Section F—Economic Science and Statistics.

The question of fatigue from the economic point of view, if possible in co-operation with Section I, Sub-section of Psychology—Prof. Muirhead	30 0 0	
		£30 0 0

Section G—Engineering.

The investigation of gaseous explosions, with special reference to temperature—(chairman not appointed), vice-chairman, Dr. Dugald Clark	50 0 0	
To report on certain of the more complex stress distributions in engineering materials—Prof. J. Perry ...	50 0 0	
		£100 0 0

Section H—Anthropology.

To investigate the lake villages in the neighbourhood of Glastonbury in connection with a committee of the Somerset Archæological and Natural History Society—Prof. Boyd Dawkins ...	20 0 0	
To conduct explorations with the object of ascertaining the age of stone circles—Sir C. H. Read	20 0 0	
To investigate the physical characters of the ancient Egyptians—Prof. G. Elliot Smith	34 16 6	
To conduct anthropometric investigations in the Island of Cyprus—Prof. J. L. Myres	50 0 0	
To excavate a Palæolithic site in Jersey—Dr. R. R. Marett	50 0 0	
To conduct archæological investigation in Malta—Prof. J. L. Myres	10 0 0	
To prepare and publish Miss Byrne's gazetteer and map of the native tribes of Australia—Prof. Baldwin Spencer	20 0 0	
		£204 16 6

Section I—Physiology.

The ductless glands—Sir E. A. Schäfer	35 0 0	
To acquire further knowledge, clinical and experimental, concerning anæsthetics—general and local—with special reference to deaths by or during anæsthesia, and their possible diminution—Dr. A. D. Waller ...	20 0 0	
Electromotive phenomena in plants—Dr. A. D. Waller ...	20 0 0	
To investigate the physiological and psychological factors in the production of miners' nystagmus—Prof. J. H. Muirhead	20 0 0	
The significance of the electromotive phenomena of the heart—Prof. W. D. Halliburton	20 0 0	
Metabolism of phosphates—Prof. W. A. Osborne ...	20 0 0	
		£135 0 0

Section K—Botany.

The structure of fossil plants—Prof. F. W. Oliver ...	15 0 0	
Experimental studies in the physiology of heredity—Prof. F. F. Blackman ...	45 0 0	
The renting of Cinchona Botanic Station in Jamaica—Prof. F. O. Bower ...	25 0 0	
To carry out a research on the influence of varying percentages of oxygen and of various atmospheric pressures upon geotropic and heliotropic irritability and curvature — Prof. F. O. Bower	50 0 0	

The collection and investigation of material of Australian Cycadaceæ, especially Bowenia from Queensland and Macrozannia from West Australia—Prof. A. A. Lawson	25 0 0	
To cut sections of Australian fossil plants, with especial reference to a specimen of Zygopteris from Simpson's Station, Barraba, N.S.W. —Prof. Lang	25 0 0	
		£185 0 0

Section L—Educational Science.

To inquire into and report upon the methods and results of research into the mental and physical factors involved in education—Dr. C. S. Myers	30 0 0	
The influence of school books upon eyesight—Dr. G. A. Auden	5 0 0	
To inquire into and report on the number, distribution and respective values of scholarships, exhibitions and bursaries held by university students during their undergraduate course, and on funds private and open available for their augmentation—Sir Henry Miers ...	5 0 0	
To examine, inquire into, and report on the character, work, and maintenance of museums, with a view to their organisation and development as institutions for education and research; and especially to inquire into the requirements of schools —Prof. J. A. Green ...	20 0 0	
		£60 0 0

Corresponding Societies.

Corresponding Societies Committee for the preparation of their report—Mr. W. Whitaker	25 0 0	
		£25 0 0
Total ...	...	£1634 16 6

The following research committees, not receiving grants of money, except in a few cases from the Caird Fund, were also appointed:—

Radio-telegraphic investigation—Sir Oliver Lodge.

To aid the work of establishing a solar observatory in Australia—(chairman not appointed).

Determination of gravity at sea—Prof. A. E. Love.

Research on the utilisation of brown coal bye-products—Prof. Orme Masson.

To report on the botanical and chemical characters of the Eucalypts and their correlation—Prof. H. E. Armstrong.

The collection, preservation, and systematic registration of photographs of geological interest—Prof. J. Geikie.

To consider the preparation of a list of stratigraphical names, used in the British Isles, in connection with the lexicon of stratigraphical names in course of preparation by the International Geological Congress—Dr. J. E. Marr.

To consider the nomenclature of the Carboniferous, Permo-Carboniferous, and Permian rocks of the southern hemisphere—Prof. T. W. Edgeworth David.

To aid competent investigators selected by the committee to carry on definite pieces of work at the Zoological Station at Naples—Mr. E. S. Goodrich.

To investigate the feeding habits of British birds by a study of the contents of the crops and gizzards of both adults and nestlings, and by collation of observational evidence, with the object of obtaining precise knowledge as to the economic status of many of our commoner birds affecting rural science—Dr. A. E. Shipley.

To defray expenses connected with work on the inheritance and development of secondary sexual characters in birds—Prof. G. C. Bourne.

To summon meetings in London or elsewhere for the consideration of matters affecting the interests of zoology or zoologists, and to obtain by correspondence the opinion of zoologists on matters of a similar kind, with power to raise by subscription from each zoologist a sum of money for defraying current expenses of the organisation—Sir E. Ray Lankester.

To nominate competent naturalists to perform definite pieces of work at the Marine Laboratory, Plymouth—Prof. A. Dendy.

To formulate a definite system on which collectors should record their captures—Prof. J. W. H. Trail.

A natural history survey of the Isle of man—Prof. W. A. Herdman.

To provide assistance for Major G. E. H. Barrett-Hamilton's Expedition to South Georgia to investigate the position of the Antarctic whaling industry—Dr. S. F. Harmer.

To inquire into the choice and style of atlas, textual, and wall maps for school and university use—Prof. J. L. Myres.

To consider and report on the standardisation of impact tests—Prof. W. H. Warren.

The collection, preservation, and systematic registration of photographs of anthropological interest—Sir C. H. Read.

To conduct archæological and ethnological researches in Crete—Mr. D. G. Hogarth.

To report on the present state of knowledge of the prehistoric civilisation of the western Mediterranean with a view to future research—Prof. W. Ridgeway.

To conduct excavations in Easter Island—Dr. A. C. Haddon.

To report on Palæolithic sites in the west of England—Prof. Boyd Dawkins.

The teaching of anthropology—Sir Richard Temple.

To excavate early sites in Macedonia—Prof. W. Ridgeway.

To report on the distribution of Bronze-age implements—Prof. J. L. Myres.

To investigate and ascertain the distribution of artificial islands in the lochs of the Highlands of Scotland—Prof. Boyd Dawkins.

To co-operate with local committees in excavations on Roman sites in Britain—Prof. W. Ridgeway.

The dissociation of oxy-hæmoglobin at high altitudes—Prof. E. H. Starling.

Colour vision and colour blindness—Prof. E. H. Starling.

Calorimetric observations on man in health and in febrile conditions—Prof. J. S. Macdonald.

Further researches on the structure and function of the mammalian heart—Prof. C. S. Sherrington.

The binocular combination of kinematograph pictures of different meaning, and its relation to the binocular combination of simpler perceptions—Dr. C. S. Myers.

To consider and report on the advisability and the best means of securing definite areas for the preservation of types of British vegetation—Prof. F. E. Weiss.

The investigation of the vegetation of Ditcham Park, Hampshire—Mr. A. G. Tansley.

To take notice of, and report upon changes in, regulations—whether legislative, administrative, or made by local authorities—affecting secondary and higher education—Prof. H. E. Armstrong.

The aims and limits of examinations—Prof. M. E. Sadler.

NOTES.

Dr. A. Smith Woodward will exhibit the new model of the Piltdown skull at the conversazione of the Geologists' Association, to be held on November 6 at University College.

A destructive earthquake occurred in Asia Minor on October 3, of which brief reports were published shortly afterwards. Fuller accounts have now arrived by letter. The epicentre was in the neighbourhood of Burdur and Isbarta, the chief manufacturing towns of the district. It is stated that both these towns, which lie about 165 and 185 miles east-south-east of Smyrna, are completely ruined. The line of the Ottoman railway from Smyrna to Aidin was damaged, but less seriously than was at first supposed, for through running was resumed in less than twenty-four hours.

The Paris correspondent of the *Morning Post* says that a committee of representatives of leading learned societies has been formed in Paris to consider the position of German and Austrian men of science and letters who have been admitted fellows of these societies in France. Since the beginning of the war there has been a movement in favour of the removal of all such fellows from the ranks of the societies to which they have been admitted in recognition of the value of the original work done by them, and on October 19 the Académie des Sciences held a meeting *in camerâ* to consider its position in the matter.

Among the results of the war will be noticed the obliteration of a large part of the usual weather information over land and sea. In the meteorological charts of the North Atlantic Ocean for November, issued by the Meteorological Office, this is particularly noticeable, and the U.S. Weather Bureau has pointed out that its useful charts of the northern hemisphere have had to be discontinued temporarily. The chart for November above referred to states that under normal conditions the North Atlantic is free from fog in that month, with the exception of a narrow zone between Cape Cod (Providence, U.S.), and Ushant, but that even in the fog zone the frequency is not more than 5, as compared with 40 per cent. in July.

At the annual meeting of the Royal Society of Edinburgh, held on October 26, the following officers were elected:—*President*, Prof. J. Geikie; *Vice-Presidents*, Prof. T. Hudson Beare, Prof. F. O. Bower, Sir Thomas R. Fraser, Dr. B. N. Peach, Prof. Sir E. A. Schäfer, and Right Hon. Sir J. H. A. Macdonald; *General Secretary*, Dr. C. G. Knott; *Secretaries to Ordinary Meetings*, Dr. R. Kidston, Prof. Arthur Robinson; *Treasurer*, Mr. J. Currie; *Curator of Library and Museum*, Dr. J. S. Black; *Ordinary Members of Council*, Dr. J. G. Gray, Prof. R. A. Sampson, Prof. D'Arcy W. Thompson, Prof. E. T. Whittaker, Principal A. P. Laurie, Prof. J. Graham Kerr, Dr. L. Dobbin, Dr. E. M. Wedderburn, Dr. W. B. Blaikie, Dr. J. Horne, Dr. R. S. MacDougall, and Dr. W. A. Tait.

The exhibition at the Royal Photographic Society's house (35 Russell Square) of Mr. Lewis Balfour's photographs of "Bird Life on the Bass Rock," is well worthy of a visit by all those who are interested in either the birds or the photography of birds. We believe that Mr. Balfour's special aim in the work was to illustrate the life-history of the gannet. After general views of the rookeries on the rock there follow on a large scale some pairs of gannets on nests, and a series of the young bird chipping its way out of the shell until it is fully hatched out. The growth and progress of the bird is shown almost day by day up to the fourteenth day, and then at frequent intervals up to the twelfth week, when it is ready for flight. Immature birds of their second, third, fourth, and fifth year's growth are shown with adults, and in various attitudes, such as enraged, fighting, carrying sea-weed, flying, arriving at the nest, and so on. These constitute about three-quarters of the whole number of the photographs, the remainder being similar but smaller series, showing black-backed, herring, and kittiwake gulls, guillemots, and puffins. The photography is almost uniformly excellent, the details of the birds showing crisp and clear. The exhibition closes on November 28.

In addition to the awards announced in April for papers read at meetings of the Institution of Civil Engineers, the council has made the following awards for papers published in the Proceedings without discussion during the session 1913–14:—A Telford gold medal to Mr. J. V. Davies (New York); Telford premiums to Messrs. W. C. Popplewell (Manchester), A. J. Knowles (Cairo), H. Gaskell, jun. (Widnes), P. Rothera (Trichinopoly); the Crampton prize to Mr. H. F. Carew-Gibson (London); and the Manby premium to Mr. W. M. Griffith (Bareilly, India). The Webb prize for the best paper on railway machinery published during the past three years has been awarded to Mr. Henry Fowler (Derby), and the Indian premium for 1914 to Mr. P. Rothera (Trichinopoly). The council has made the following awards in respect of students' papers read during the session 1913–14:—The "James Forrest" medal and a Miller prize to Mr. J. E. Swindlehurst (Birmingham); and Miller prizes to Messrs. T. C. Grisenthwaite (Glasgow), H. J. C. Harper (Bristol), W. P. Nevett (Birmingham), J. M. L. Bogle (Manchester), E. A. Cross (Birmingham), S. Brassey-Edwards (Manchester), G. T. Cotterell (Bristol), D. D. Stanier (Newcastle), W. E. Gurry (London), H. Taylor (Birmingham), and R. C. Rattray (Manchester).

In *Man* for October, 1914, Mr. A. L. Lewis discusses the standing stones and stone circles of Yorkshire. No dolmens or large non-sepulchral circles seem to be found in the county, but there are numerous so-called "barrow circles," that is, small circles of stones surrounding tumuli. Many of these have been destroyed, and it is difficult to find those which survive amid the heather of the moors. On the other hand, Yorkshire possesses some very remarkable menhirs, or standing stones, which may be said to form a class by themselves. The longest standing stone in the British Isles is that in the churchyard at Rudstone, near Bridlington, which, so far as excavations have been made, is 40 ft. in height. It faces the line of May-day summer or thereabouts, and it is a mass of coarse ragstone or millstone grit, the place of origin of which is uncertain.

IN the *Philippine Journal of Science* for April Mr. E. B. Christie discusses the question of irrigation in Ilocos Norte province. It is carried out by a system of co-operative societies, and the procedure at the digging of a canal is a curious blend of Christian and pagan observances. Most of these societies are under the patronage of a saint, and they hold an annual festival at the conclusion of the harvest season. A mass is sung before the ceremony, and food and drink are laid out for the spirits. When the site for a new canal is selected, a cross is erected. Means are then taken to propitiate the local spirits, presumably because they are supposed to be offended by the disturbance of the soil. Omens are taken to fix a lucky time for the rite. Offerings of a coconut, a chicken, tobacco, and spirituous liquor are laid on an altar. Then an animal, a pig, or an ox is sacrificed near the trench, into which the blood is allowed to drip, with the invocation: "Ditch, this blood is spurted into you in order that the current may be as strong as the current of this blood." The body of the victim is then dragged along the bed of the canal as far as the plot of ground which is to be irrigated. Sometimes a dog is killed and its blood is sprinkled on a plot of ground which is to be levelled to form a rice-field, the dog being eaten afterwards. Animal victims are also said to be buried in the masonry of the canal intakes or gates—a good example of the foundation sacrifice which has been described by Sir E. Tylor.

AT the end of the long systematic excavation work conducted by Mr. W. Pengelly in Kent's Cavern, Torquay, there were great quantities of the cave deposits left undisturbed. A little similar work has since been done there which has led to the discovery of other chambers and passages, and the finding of many more of the usual kind of cavern relics. Recently more persistent excavation has been made by Mr. C. Cox, who three years ago went to reside near the cavern. Becoming greatly interested in it and its history, he gives all the time freely spared from his vocational needs to excavating and acting as voluntary guide to the cavern. He has worked out a new passage for some 60 ft., and has obtained numerous fine examples of the cavern products, including well-worked flint palæoliths, jaws, teeth, and other bones in great variety. A week or two ago while moving the earth of the floor of the sloping chamber near the entrance of a channel he intends to excavate, he found a tooth of more than usual interest, having an appearance which suggested human origin. Local medical experience confirmed his conclusion that it is a front tooth of a human being. It is, however, imperfect, being split laterally; the inner portion with the extreme end of the root is missing, so that the specimen is really only the larger outer half of an incisor. Its length is 17 mm., width across the crown, 9 mm., and depth of the enamel face about the same measurement. The enamel edge projects beyond the inner surface, indicating a position in the upper jaw, and permits it being determined as a well-worn left upper human incisor. It may be noted in connection with this find that, occurring in the floor some 3 or 4 in. below the present surface, it would be recorded in the terms used by Pengelly as lying in the fifth-foot level of the cave earth, beneath some two or more feet of granular stalagmite that formed the original floor of the Sloping Chamber.

IN the September-October number of *Bird-Lore* Mr. L. A. Fuertes continues the record of his impressions of the notes of tropical birds, dealing in this instance with toucans (illustrated by a coloured plate), cuckoos, trogons, motmots, etc. From their loud and incessant cries, brilliant colouring, and large size, most of the members of the first-named group would, it might be thought, be extremely easy of detection. As a matter of fact, this is far from the case, the explanation, so far as coloration is concerned, being that the brilliant tints of the birds, inclusive of their great uncouth beaks, harmonise closely with those of the tropical vegetation, and the intervening rays of sunlight, amid which they perch.

NOWADAYS much of the work on mammals by American writers relates to races and so-called species of little or no general interest. An exception occurs in a paper on South American squirrels contributed by Dr. J. A. Allen to the Bull. Amer. Mus. Nat. Hist., vol. xxxiii., pp. 585–597, in which will be found the description of a new generic type (*Notiosciurus rhoadsi*) from the Andes of Ecuador, distinguished from other tree-squirrels by the structure of the hind feet. In those of other species the greater portion of the sole is bare, with the toe-pads separate, and widely sundered from the narrow heel-pad. In the new form, on the other hand, the bare area is restricted to a small patch immediately behind the toes, with the toe-pads crowded together, and the heel-pad, which occupies nearly the whole width of the foot, in close apposition.

THE ecology of local fresh-water fishes forms the subject of an interesting illustrated article by Dr. S. A. Forbes, published as a pamphlet by the Illinois State Laboratory of Natural History. Difference in habitat and food forms a basis for grouping fresh-water fishes, although, as the author acknowledges, no hard-and-fast lines of division can be drawn from these. Very noteworthy is the fact that one of the largest American species, the spoon-beaked sturgeon (*Polyodon spathula*), is almost the only one which feeds on plankton when adult, although this constitutes the diet of practically all species in their infantile condition. Some kinds pass directly from this to the permanent food-stage, but in the sheep's-head (*Haplodinotus grunniens*) there is an intermediate insectivorous stage between the infantile plankton-phase and the permanent mollusc-crushing habit.

To the October number of the *Zoologist* Mr. J. C. Moulton, curator of the Sarawak Museum, contributes an account of a collecting expedition in the Sarawak province of Borneo, in which he followed to a great extent the route taken by Dr. Wallace more than half a century ago. In the Sadong district, where the great naturalist often saw three or four in a day, orang-utans are now much scarcer than in Wallace's day, despite the fact that they are protected by Government, except when, as occasionally happens, one of them takes to raiding fruit-trees, when its destruction is permitted. Two photographs of groups of land-Dayaks are of considerable interest. These people—formerly persecuted by head-hunting sea-Dayaks—are the only tribe in Sarawak retaining customs indicative of Hindu influence, due, no doubt, to their Javanese origin.

SOME years ago the Indian Museum published the first part of "An Annotated List of the Asiatic Beetles in the Collection." More recent work, by Mr. H. Gravely, on the Passalidæ—a family nearly related to the Lucanidæ, or stag-beetles—showed that the continuation of a mere list of localities was, in the present state of our knowledge of that group, altogether insufficient, and that illustrated descriptions of all the Oriental species were urgently required. This led to an inquiry into the general principles adopted in the current classification of the family, which was found to require but little modification in order to render it satisfactory from a modern point of view. The result has been a monograph of 176 quarto pages, illustrated with three plates, of the Oriental members of the family, issued as No. 4 of vol. iii. of Memoirs of the Indian Museum. As remarked by the author, the figures of the heads of the various species will be of permanent value, even if some of the systematic portion of the work may require revision.

To the author, Mr. F. Cole, we are indebted for a copy of an article on the history of anatomical museums, reprinted from "A Miscellany: Presented to J. M. Mackay, LL.D." (Liverpool and London, 1914). In discussing the earlier museums, the author points out that these had to depend almost exclusively on desiccation and injection for the display of the anatomy of the soft parts, and that skill in making such preparations attained a development which in certain cases has never afterwards been equalled. Even after the introduction of alcohol as a preservative medium, the use, both of the spirit itself and of the glass vessels in which it is contained, was greatly restricted by their cost, the Hunterian Museum, which, in its founder's time, was unusually rich in moist preparations, having only 4829 of that type, as against 8636 not requiring fluid. The purely anatomical museum attained its zenith with John Hunter, whose collection, in the author's words, had no rivals and no imitators. "Modern ideals discover a narrower outlook, and a relaxing hold on anatomical verity. The museum of the present day is designed to illustrate, first the general principles of classification, and afterwards the elements of systematic anatomy."

THE report of the Refrigeration Research Committee of the Institution of Mechanical Engineers was presented at the meeting of the institution on October 16. With regard to the rating of refrigerating machines, it recommends that the refrigeration be expressed in (kilogram) calories per second, that the standard conditions be, for the cooling water, 15° C., at inlet to 20° C. at outlet, for the cooled material, 0° C. to $-5°$ C., the temperatures being those of steady working; the refrigeration produced under these conditions to be called the "rated capacity" of the machine. The coefficient of actual performance is the ratio of the refrigeration to the work spent in driving, that of ideal performance the ratio of the refrigeration to the work spent in an ideal adiabatic cycle with the same initial and final temperatures and pressures. The quotient of the two performances is to be the "relative efficiency." The report contains entropy-total heat charts for carbonic acid, ammonia, and sulphurous acid, the last two being provisional only. The chairman, Sir A. Ewing, has added an appendix showing the great convenience of the entropy-total heat charts as compared with the entropy-temperature charts in calculations respecting refrigerating machines.

VOL. XI. of the Collected Researches of the National Physical Laboratory consists of reprints of fourteen memoirs by the staff of the institution, which have appeared recently in the Proceedings of scientific societies or in the technical Press, and extend to more than 300 pages. Some idea of the importance of the work carried out at the laboratory may be formed by noting a few of the conclusions to which the authors of these memoirs have arrived in the course of their investigations. Mr. F. E. Smith finds the value of the ohm by his modification of the method of Lorenz slightly less than it has been taken in the past—106·25 instead of 106·30 cm. of mercury. Drs. Harker and Kaye conclude that when a heated metal vaporises it sends out, in addition to the ordinary uncharged metallic particles, electrically charged particles which are shot out at right angles to the metallic surface and produce electric currents of the order of an ampere. Dr. Rosenhain and his staff show that there is a transition point for iron about 900° C., and provide further evidence in support of the theory of the existence of an amorphous cement between the crystals of metallic substances. Mr. Paterson and his colleagues prove that the electrometer must be given a place amongst the instruments suitable for standard measurements in electrical engineering. Dr. Stanton shows how inadequate are the accepted formulæ for the flow of viscous liquids through pipes to represent the actual facts, and Mr. Baker gives the results of his investigation of the effects of the lengths and shapes of bow and stern portions of mercantile ships on the resistance at various speeds. It is to be hoped that the national importance of work of this type will not be overlooked even in such times as the present.

Engineering for October 23 contains an illustrated account of the United States Fleet collier, *Jupiter*, which is of special interest at the present time in view of the importance of the rapid recoaling of warships. The ship is of the twin-screw, single-deck type, and is designed for a speed of 14 knots when at a loaded displacement of 19,230 tons. In addition to having interesting equipment for the handling of coal and oil fuel, the vessel is notable, as the propellers are driven by electric motors, current being supplied to these by turbine-driven generators, the shaft-horse-power available for propulsion being 5500. The total cargo capacity is 966,260 gallons of oil and 9856 tons of coal, or, alternatively, 405,620 gallons of oil and 11,380 tons of coal. The coal handling gear was supplied by the Mead Morrison Manufacturing Company, and the stipulation of the contract was for the delivery of 100 tons per bucket per hour when the gear was operated by winchmen of one week's experience. Owing to the large number of towers supporting the booms and rigging of the coal handling plant, the appearance of the vessel is somewhat unusual.

The *Scientific American* for October 3 draws a contrast between the ordinary European frontier with its enormous forts and lines of strategic railways, and the Canadian frontier. On the continent of America, the two greatest nations of the world have a common frontier which extends, unbroken, for some 4000 miles. Throughout the whole of this frontier there is not to be found, on either side, a single fortification, or any offensive or defensive military work of any kind whatsoever, and this is the case despite the facts that this far-flung frontier was the eventual outcome of a fierce war, and that these two powerful nations have always been engaged in keen commercial rivalry. That heavily fortified frontiers, backed by military railways, are a menace to a friendly neighbouring State, and provocative of responsive military works, and that they produce an atmosphere of international suspicion and dislike cannot be disputed. There is a growing conviction that the failure of the Teutonic attempt to establish a military dictatorship in Europe will be followed by the final subjugation and control of militarism. Our contemporary can think of no guarantee that would be more effective than the complete obliteration of these fortifications, modern in construction, but essentially medieval in conception, which disfigure European frontiers.

Messrs. John Bartholomew and Co., of the Geographical Institute, Edinburgh, have published a new reduced survey map of north-eastern France, Belgium, and the Rhine. The map is coloured orographically, and is on the scale of sixteen miles to an inch. This scale makes it possible to show with clearness the railways, fortresses, main and secondary roads, and frontier custom-houses. Heights are given both in metres and feet, and the distances between road junctions are marked. The price of the map is 2*s.* on paper, and 3*s.* mounted on cloth.

The following forthcoming books of scientific interest are announced by *Messrs. G. Bell and Sons, Ltd.*:—X-Rays and Crystal Structure, by Prof. W. H. Bragg; Quantitative Laws in Biological Chemistry, by Prof. Svante Arrhenius; Tuberculosis: a General Account of the Disease, its Treatment, and Prevention, by Dr. A. J. Jex-Blake; Woollen and Worsted Cloth Manufacture, by Prof. R. Beaumont, illustrated; Buddhist Psychology, by Mrs. Rhys Davids. The list of *Messrs. Methuen and Co., Ltd.*, includes:—My Life, by Sir Hiram S. Maxim; On Alpine Heights and British Crags, by G. D. Abraham, illustrated; How to Know the Ferns, by S. L. Bastin, illustrated; British Insects and How to Know Them, by H. Bastin, illustrated; The Mammary Apparatus of the Mammalia in the Light of Protogenesis and Phylogenesis, by Prof. E. Bresslau, illustrated; Mind Cures, by G. Rhodes; and the following first volumes of Methuen's Health Series:—The Eyes of Our Children, by N. B. Harman; Throat and Ear Troubles, by M. Yearsley; The Teeth, by A. T. Pitts; The Care of the body by Dr. F. Cavanagh; The Health of a Woman, by Dr. H. J. F. Simson; Health for the Middle-Aged, by Dr. S. Taylor; The Prevention of the Common Cold, by Dr. O. K. Williamson; and The Hygiene of the Skin, by Dr. G. Pernet.

OUR ASTRONOMICAL COLUMN.

The Rotation Periods of two of Saturn's Satellites.—In the Bulletin (No. 64) of the Lowell Observatory Prof. Lowell and Mr. Slipher publish their observations in relation to two of the satellites of Saturn, namely, Mimas and Enceladus, which have led them to deduce that the revolutions and axial rotations of these bodies are synchronous. This investigation on the brilliancy of these satellites was carried out in December, 1913, and the first three months of the present year, and resulted in finding out that these bodies are of very unequal albedo in different parts of their apparent orbits, and the variations recur *in situ* showing that the satellites always turn the same face to their primary. Both the moons appear brightest near their western elongations and faintest near their eastern. Their magnitudes and ranges are given as follows:—Mimas, 12·90 to 13·33; Enceladus, 12·33 to 12·67. Both these bodies are too small to show a disc, so their size has been inferred from their brilliancy relative to Tethys. Two figures accompany the text, in which the observations are plotted diagrammatically.

Difference of Longitude between Paris and Nice.—In a communication by M. B. Jekhowsky, presented to the Paris Academy of Sciences (*Comptes rendus*, vol. clix., No. 15, October 12) by M. P. Appell, a brief summary is given of the determination of the difference of longitude between Paris and Nice. The astronomical observations have been made at both these stations with the "modèle géodésique de l'astrolabe à prisme," by the eye and ear method, and the chronometric comparisons were made by wireless after the method of MM. A. Claude, G. Ferrié, and L. Driencourt. The chronometer rates were controlled both before and after the astronomical observations by pendulums, and comparisons were made at the beginning and end of each series of observations. The daily wireless time signals from the Eiffel Tower were utilised as a check on Paris and Nice chronometers between the two series of evening observations. The observations were made on the evenings of May 3, 6, 31, and June 5, and the final result of the difference of longitude between Paris and Nice is given as 0h. 19m. 51·204s. ± 0·06s.

Effect of Humidity on Photographic Plates.—It has been previously pointed out that when a photographic plate has been exposed in a telescope for some time the plate gradually loses some of its sensitiveness.

This question is the subject of a short communication to the *Astrophysical Journal*, September, vol. xl., No. 2, by Dr. C. E. Kenneth Mees, of the Kodak Research Laboratory, who, thinking that the cause was due to a change in humidity, made experiments to determine the effect of varied humidity on the sensitiveness and development factor of Seed 23 and Seed 30 plates. Experimenting within a range of 0·5 to 85 per cent. of humidity, and giving the emulsion film time to come into equilibrium with the air, he found that both sensitiveness and development factor decreased about 25 per cent. when the humidity was increased from 0·5 to 85 per cent. This result seems very conclusive, and shows the restraining action of a change of moisture on the sensitiveness of photographic film. Dr. Mees suggests that all photographic materials used for photometric work should be brought previously into equilibrium with the atmosphere in which they are to be used.

Tests of a 24-in. Objective.—At the end of the year 1911 the erection of a 24-in. refractor was completed for the Sproul Observatory, U.S.A. The objective was made by Brashear, the crown disc being furnished by the Parra-Mantois firm of Paris, and the flint disc by Schott and Genossen, of Jena. In 1912 the objective underwent a series of tests at the hands of Profs. John A. Miller and Ross W. Marriott, who used the method of extra-focal images devised by Hartmann. In 1913 a final series of tests was made, and this, with the foregoing, are described by the authors in the October number (vol. clxxviii., No. 4, p. 465) of the Journal of the Franklin Institute. It seems that in the first tests measures of photographs of star images taken through a screen containing circular holes showed certain discrepancies among the focal distances of different parts and zones of the lens, which, while not excessive, were absent before the mounting of the lens. The cause of these discrepancies was traced to a side pressure spring to prevent the objective from sliding in its cell. After a reduction of the pressure further tests were completed with screens containing different numbers of holes. The result was to show that "from every standpoint the lens is an excellent one."

THE RECTORSHIP OF THE UNIVERSITY OF GLASGOW.

THE matriculated students of the University of Glasgow, divided into four "nations" under the ancient constitution derived from Bologna and Paris, have unanimously elected M. Raymond Poincaré, President of the French Republic, and member of the academy, to be their rector for a term of three years. For a long time past the recurring elections to the rectorship have been conducted on purely political lines, and the result was always hailed as a party triumph for one side or the other. Mr. Disraeli (1871) was succeeded by Mr. Gladstone (1877), and Mr. Bright (1880); Mr. A. J. Balfour (1890), Mr. J. Chamberlain (1896), Lord Rosebery (1899), Mr. Asquith (1905), and Lord Curzon (1908), were followed by Mr. Birrell (1911).

Before the present national crisis arose, Lord Strathclyde, Mr. Bonar Law, and Mr. R. B. Cunninghame Graham had been selected as their champions by the several political groups. But the students speedily recognised that in the actual situation of the country a party contest was out of place, and the candidates first chosen were withdrawn. The political leaders thereupon, in token of "the close bond of union between France and Great Britain," addressed a joint invitation to M. Poincaré, which the President was pleased to accept. The proposal was received with enthusiasm, and unanimously endorsed by the students. In the absence of any other nomination, the Principal, Sir Donald MacAlister, K.C.B., on behalf of the Senate, at noon on Saturday, October 24, declared M. Poincaré duly elected by the votes of all the "nations."

The rector is the official President of the University Court. He appoints an assessor, who is *ex officio* a member of the governing body. He is "installed," and delivers a rectorial address, at a solemn assembly of the University during the period of his tenure. Otherwise his position is honorary. In the present case the "installation" will have to await the termination of the war.

The names of two relatives of the new rector, Dr. Henri Poincaré and Dr. Boutroux, already appear on the University's roll of honorary graduates. From the beginning of the sixteenth century onwards a Glasgow graduate has from time to time been chosen as rector of the University of Paris. This is the first occasion on which a French scholar has held the rectorship of Glasgow.

THE ROYAL ANTHROPOLOGICAL INSTITUTE.

PROF. ARTHUR KEITH publishes in the Journal of the Royal Anthropological Institute for January–June, 1914, his presidential address on the reconstruction of fossil human skulls. This is, to a large extent, the outcome of the controversy which arose on the reconstruction of the Piltdown skull, in which his scheme differed from that suggested by Dr. Smith Woodward. As a practical test of his methods Prof. Keith invited Dr. Douglas Derry to furnish him with fragments of a specimen skull, which he engaged to reconstruct and to publish the results of his experiment, whatever might be the result. The reconstruction of this skull by Prof. Keith so closely, in his opinion, resembles the cast of the original skull from which the fragments were taken as to confirm the validity of his methods. He is thus led to deny that the architecture of the human skull lies outside the limits of true science. He asserts that it is framed according to definite principles, that all its parts are correlated, and that it is possible from a part—if our knowledge is accurate and full—to reconstruct the whole. The address marks a decided advance in our knowledge of the science of craniometry.

Mr. Henry Balfour contributes to the journal an interesting paper on the art of fire-making with a flexible sawing-thong. This method of fire-production has been traced in three distinct localities: an eastern area extending from Assam to New Guinea; by Miss Mary Kingsley among the Ba-Kele of the Ogowe River in West Africa; and in Sweden, Germany, and Russia, where it is used as a means of procuring need-fire. This strange distribution of the art raises many interesting questions, particularly in relation to the theories of Graebner and his school, who postulate the derivation of these and similar ideas from a single well-defined area, whence they are generally transmitted. In the eastern area it seems to be associated with the Negrito culture, and is possibly a variant of the better known rigid, blade-like fire-saw. In Africa, again, an independent origin is strongly suggested, although the possibility of transmission from the east cannot be quite ignored. In Europe the theory of transmission from the Negritic, Indonesian, pre-Malayan, or Bantu culture can be accepted only with much reservation, and here, too, the inference is that it was independently discovered. Much still remains to be done by examining museum specimens and by the collection of examples from other parts of the world. Mr. Balfour pleads for assistance in adding to the fine collection of material in his charge in the Pitt-Rivers Museum, Oxford.

The journal also contains an elaborate, well-illustrated paper on the antiquity of man in Ireland as traceable in the older series of flint implements. Needless to say, the character of some of the specimens obtained from the raised beach at Larne and other sites in North Ireland has formed the subject of active controversy, Mr. Knowles asserting that they are human artefacts, while other authorities, as in the case of the eoliths, deny that they are the work of man. In this paper Mr. Knowles urges the validity of his theory with much vigour, and he recognises in some specimens striæ which prove that they belong to the Ice age. He sees in some of them a remnant saved from the precursors of the Chellean and Achulean *coups de poing* of France and the south of England. His arguments deserve serious attention, but it is perhaps too much to say that he will succeed in convincing his opponents.

The institute under its present management has made a decided advance. Its members now number 534—the highest point hitherto attained—as compared with 367 in 1913. During the year it has been engaged in various schemes of research, and has strongly advocated the teaching of anthropology to candidates for the Indian and Colonial Civil Services. But a larger membership is much to be desired, because many important projects, and, in particular, the reorganisation of the library, have been postponed through lack of funds. The present housing of the institute leaves much to be desired, and it is scarcely creditable to the British, Indian, and Colonial Governments and the large number of officials and colonists throughout the Empire that a decided effort has not been made to place this valuable institution on a sounder footing.

PROBLEMS OF THE ANTARCTIC.

ONE of the most noteworthy meetings during the Australian session of the British Association was the discussion at Sydney on the past and present relations of Antarctica in their biological, geographical, and geological aspects. The four sections of zoology, geology, geography, and botany held a joint meeting for this purpose on August 25, with Prof. A. Dendy in the chair. Sir Douglas Mawson, who had only reached Sydney the day previously from London, was to open the discussion, but he devoted his time more specially to a general account of the work of the Australian Antarctic Expedition. He expressed his belief in the existence of only one land mass in Antarctica. Prof. T. W. Edgeworth David touched on several points. The uneven level of the ice-barrier at its seaward edge could be adequately explained only by its containing beneath its surface flattened-out ribs of glacier ice from the glacier valleys to the south-west and south-east of the barrier. These would account for the inequalities in level of the barrier face, which varies from 20 to 150 ft. above sea-level. In this connection Prof. David pointed out how in the heavily faulted rock strip of South Victoria Land cross faulting had produced low points in the horst through which the inland ice had run. He also dwelt on the importance of the study of Antarctic meteorology in relation to the weather of Australia, and emphasised the value of the Macquarie Island meteorological station.

Mr. Griffith Taylor spoke at some length on glacial erosion. He contended that in 78° S., the latitude in which his observations were made, there is little or no glacial erosion, that it is too cold for it to act, and that the present sculpturing of the land is due to the effects of alternate thawing and freezing. As proof of this theory, he pointed out that the streams flowing from glaciers in summer are clear and not muddy, as, for instance, in the Alps.

Mr. H. T. Ferrar, who was not in entire agreement with Mr. Taylor about erosion, spoke of the tectonics of the continent of Antarctica. He maintained that the evidence showed that the continent had been under a torsional strain. The Pacific side had fallen and caused the Andean fold while the rest stood firm. Mr. Ferrar agreed with Prof. David about the structure of the great ice-barrier.

Prof. A. Penck brought the discussion back to the main problem. He pointed out the oneness of South Victoria Land with Eastern Australia and the absence of folding since Palæozoic times. On the other hand, Graham Land shows a complete divergence from this structure, and a marked similarity to South America, in its folded beds of Tertiary age and marine origin. The great problem is, How are these two regions of Antarctica, so strikingly opposed to one another, joined? It was formerly suggested that the Andean folds were continuous into Edward Land, but this theory found no support in the geological evidence collected by the Amundsen Expedition in that land. Prof. Penck held that the possibility of a strait across Antarctica was not yet disproved.

Dr. R. N. Rudmose Brown agreed that the main problem of Antarctic exploration was to discover the connection between the two divergent structures of Victoria Land and Graham Land. This would be a justification for a long transcontinental journey like that contemplated by Sir Ernest Shackleton. Dr. Brown disagreed with Prof. Penck as to the existence of a strait across Antarctica, and said that the discoveries of Shackleton and Amundsen in the Ross Sea area and those of Bruce and Filchner, as well as the increased probability of the actual existence of Morrell Land, left no room for such a strait. He pointed out that the Deutschland Expedition has not disproved Morrell Land, but that it had, on the other hand, lent colour to its existence.

Capt. J. K. Davis emphasised the importance of deep-sea work around Antarctica, and gave some account of his own explorations and discoveries south of Tasmania in the *Aurora*. He pointed out how little of the coast line of Antarctica was known, and insisted that this important part of Antarctic discovery could be more satisfactorily and easily done from sea than by land journeys. Capt. Davis said he wished to place on record his great indebtedness to Dr. W. S. Bruce for the invaluable help he had given him in deep-sea apparatus and advice in its use.

Mr. F. L. Stillwell spoke of the geological work he had done with the Mawson Expedition, and showed specimens of the rocks obtained. He showed that Adelie and Wilkes Land are of the same plateau structure as Victoria Land.

Dr. G. C. Simpson suggested that an area of five million square miles radiating solar energy into space must have an effect on atmospheric circulation which had not so far been given full importance. Dr. Simpson spoke at length on Antarctic meteorology in Melbourne to Section A.

Other speakers included Prof. A. C. Seward and Mr. C. Hedley, and while the discussion cannot be said to have shed much new light on the main problems of Antarctica, it afforded a useful interchange of views and evoked great interest in Sydney. The time proved all too short for the number of speakers available, who were in consequence almost limited to actual explorers.

R. N. RUDMOSE BROWN.

CLIMATE AS TESTED BY FOSSIL PLANTS.[1]

PROBLEMS connected with the climates of past ages have long exercised the minds of scientific writers, both from the astronomical point of view and from the point of view of the gradual development and distribution of plants and animals, since the earliest periods that have left recognisable records in the earth's crust. My task this evening is to deal with the nature and value of the evidence afforded by plants as to the climates at different periods of the world's history. Even before the study of fossil plants attained the dignity of a science (1706) the opinion was expressed that certain leaves preserved as impressions in Palæozoic strata in Germany bore a closer resemblance to existing tropical genera than to any European forms; and as investigation of the botanical records of the rocks progressed it became increasingly evident that fossil plants often exhibit a close agreement with species characteristic of regions warmer than those where the fossils are found. Plants, it has been said, "are the thermometers of the ages, by which climatic extremes and climate in general through long periods are best measured." It seems a simple matter to draw conclusions as to the climates of former ages from the nature of the vegetation embedded in the rocks; but the more we consider the facts the more fully we recognise the difficulties of interpretation.

At the outset of our inquiry we must endeavour to obtain some general conception of the relation of existing plants to the diverse influences to which they are exposed in order to appreciate their plasticity or power of modifying form and structure in response to the demands of the environment. Plants have generally been preferred to animals as indices of climatic change on account of their inability to escape from uncongenial or injurious conditions unless the change in climate is sufficiently gradual to allow time for migration by the precarious method of travelling afforded by the adaptation of fruits and seeds to dispersal by wind, water, or animal agency. Plants must either become acclimatised or suffer extinction, while animals, unless faced by impassable barriers, can change their home. It is therefore of importance to obtain some general idea of the power of plants to accommodate themselves to changed conditions, and to inquire how far the factors influencing plant-life are able to cause alteration in form or structure and so maintain equilibrium between the organism and its environment. It is well known that closely allied plants can exist under very different conditions, but we are unable to give any satisfactory explanation of this power of adjustment inherent in the constitution of a species. As Prof. Judd reminds me, tropical species in St. Petersburg live through the winter in semi-darkness in glass houses with the roof darkened by a thick covering of matting and snow. The same species is occasionally met with in both temperate and tropical regions: the bracken fern, which monopolises wide stretches of British moorland, grows in tropical Africa, in the Alps and Himalayas, China, the Malay Peninsula, Tasmania, and many other parts of the world where it is exposed to a wide range of climatic conditions. In contrast to this and other cosmopolitan types there are many instances of ferns and flowering plants characterised by a narrowly circumscribed geographical range: some of the genera now confined to a comparatively small area in the tropics are survivals from a remote past when they, or closely allied forms, were widely spread in northern countries. If we take the climatic environment of the surviving species as an index of the conditions under which their predecessors flourished, their presence in European sedimentary rocks points to tropical or subtropical conditions in the Mesozoic era in latitudes now characterised by a temperate or even an Arctic climate. It is, however, very probable that the last strongholds of these ancient and possibly enfeebled types are characterised by climatic conditions less rigorous than those under which their more robust ancestors were able to exist. The "big trees" of California, the genus Araucaria, and the Malayan ferns Dipteris and Matonia afford striking examples of genera now restricted to a small area but formerly very widely distributed. The two surviving species of Sequoia (the redwood and the mammoth tree), now confined to a narrow strip of land bordering the Pacific coast, are the last members of a family that has left many traces of its existence in Tertiary Europe and in other parts of the world. Similarly Araucaria, one of the most venerable of our Conifers, is now confined to Chile and Brazil in the west, and to the eastern part of Australia, New Caledonia, and other Australasian islands, whereas in the Jurassic period species closely allied to the monkey puzzle (*Araucaria imbricata*) and the Norfolk Island "Pine" (*Araucaria excelsa*) flourished in North America, Europe, and other regions north of the equator. A similar history of retreat from northern latitudes to a much more limited tropical home has been deciphered from the remains of Mesozoic ferns that have their modern counterparts in the Malayan genera Matonia and Dipteris.

Though we cannot make any definite statement as to the mode of action of heat on the living protoplasm of a plant, it is possible to formulate some general rules governing response to external factors as illustrated by differences in habit and anatomical characters. The striking contrast in the environment of land and water plants means a considerable difference in the conditions affecting the working of the plant-machine. A species surrounded by water has no need to take measures for the reduction of evaporation or, more accurately expressed, transpiration: the superficial cells require no waterproof covering to prevent loss of moisture from the internal tissues; the water-conducting tissue (or wood) is much less developed in a plant that is not dependent on its roots alone for a supply of raw material. If we cut across the stem of an aquatic flowering plant, *e.g.* the mare's-tail or the water milfoil, we find that the feebly-developed conducting strands are nearer the centre than is the conducting tissue of a land plant. The tensile strain to which the stem is exposed renders desirable a concentration of the strongest tissue, in this case the wood, towards the axial region as compared with the more peripheral disposition of the corresponding tissue in a stem exposed to the bending force of the wind. The stem of the water-plant contains large air-spaces which ensure the provision of an internal atmosphere and an adequate supply of oxygen to the living cells; the support afforded by the surrounding water renders superfluous any special strengthening tissue such as characterises the stems of land-plants in which it is so arranged as to secure maximum efficiency with the least expenditure of material.

Plants growing in dry climates where water is available only at certain seasons, often separated by long intervals of drought, are characterised by structural features correlated with the economising or storing of water. A relatively thick cuticle—an impervious film on the surface of the aerial organs—reduces the loss of water in the form of aqueous vapour from the system of intercellular spaces permeating the internal tissues. The minute pores or stomata regulating gaseous exchange between the plant and the external air, and by which aqueous vapour escapes, are often sunk below the level of the epidermis, or the leaves are variously modified in response to the need of reducing evaporation. The formation of water-storing tissue may result in the development of a succulent habit; hard spines replace the flat green leaves, thus by a reduction of exposed thin surfaces effecting a considerable diminution in the amount of water evaporated. In some cases the leaves persist as fleshy storage-reservoirs. Occasionally special cells occur in the leaves of dry-climate plants, in plants the water-supply of which is precarious, which act as small reservoirs to be drawn upon in times of stress. The intercellular spaces that form large cavities in the stems and leaf-stalks of aquatic plants are reduced to the minimum consistent with adequate aeration. Such anatomical features are by no means the monopoly of members of desert floras; they are characteristic of plants growing under conditions in which for various reasons economy in the use of water must be exercised. In salt marshes the water, though abundant enough, contains a relatively high percentage of salt, and this checks absorption by the roots; to avoid the danger of a greater loss of water from the leaves than can be made good by the roots, the plant assumes a habit and anatomical features similar to those characteristic of desert forms. Habitats where water may be plentiful, but to which plants react by acquiring the appearance and structure of species growing in dry regions, have been termed physiologically dry. A salt-marsh plant lives in a physiologically dry habitat; desert plants live in a physically dry locality, and though the environments differ they induce a similar reaction on the part of the two sets of plants. Peat-bogs afford another example of a physiologically dry habitat: the abundance of humic acids in the soil retards water absorption and so reacts on form and structure. In the swampy soil of a fen oxygen is scarce, and the horizontal underground stems of fen-plants tend to avoid the deeper water-logged soil by growing unusually near the surface.

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[1] Lecture delivered before the Royal Meteorological Society on March 18 by Prof. A. C. Seward, F.R.S. Reprinted from the Quarterly Journal of the Society.

The action of heat and cold is less easy to analyse; the thick covering of bark on the stem of a woody plant is primarily a protection against drought and not against cold. It is rather in the habit of plants than in any specific anatomical features that exposure to cold is reflected. In Russian Lapland it has been shown that it is not the low temperature but the effect of the dry winds that sets a limit to the northward extension of the forests; the young shoots, exposed to the desiccating influence of the air, lose more water than the roots can replace by their enfeebled power of absorption from the cold ground.

The contrast in habit and anatomical structure between individuals of the same species grown at high elevations in the Alps and in the lower meadows is due in part to the action of light and to other factors affecting water-supply. Plants grown before a continuous light under conditions similar to those in high latitudes, afford evidence in their power of response to a changed environment of the remarkable plasticity of vegetative organs; the stems are shorter, the amount of wood and fibrous tissue is reduced, and the cell-walls are thinner than in plants grown under normal conditions. The difference in the intensity of light on the sunny as compared with the shaded side of a tree leaves an impress on the structure of the leaves; a sun-leaf is thicker and is richer in the so-called palisade cells, that is, the cells containing chlorophyll elongated at right angles to the surface of the leaf, than the leaves which grow in diffused light.

The occurrence of the same or closely related species of existing plants under very different climatic conditions is a serious obstacle in the way of employing fossil plants as indices of climate. While it is possible to draw certain general conclusions from the facies of a flora as represented by fossils that can be identified with recent forms, the difficulties are enormously increased when the fossils are extinct types and too distantly connected with living species to afford any safe guide as to the conditions under which they were able to live. It is, for example, certain that in the Tertiary and Cretaceous epochs the vegetation of Arctic regions was such as could not have withstood the low temperature that now characterises Greenland, Spitsbergen, and other ice-covered countries. It is probably safe to assert that in latitude 70° N. in the Cretaceous and the succeeding Tertiary period the temperature was at least as high as that in southern Europe at the present day. This statement is based on the present geographical distribution of recent plants with which the numerous fossils discovered on the west coast of Greenland are most nearly related. It is, of course, impossible to say to what extent the fossil species differed from their surviving relatives in the power of resisting unfavourable conditions, but the fact that many of the Greenland fossils are very closely related to plants now confined to tropical and subtropical countries carries more weight than if the evidence rested on one or two isolated cases. The occurrence in Lower Cretaceous rocks on the west coast of Greenland of fossil ferns very similar to living species of the common tropical genus Gleichenia affords one of several instances of the vicissitudes and changing climates to which groups of plants have been exposed.

The preservation of plants as petrifactions affords valuable data in connection with climatic questions, but it is unfortunately only in comparatively rare instances that the relics of ancient floras retain their tissues in a state that admits of microscopical investigation. In some of the Lancashire and Yorkshire coal seams there are calcareous nodules containing numerous petrified fragments of the stems, leaves, roots, seeds, and spores of plants that flourished in the Carboniferous forests, and by cutting transparent sections of these blocks of stone the tissues can be examined as thoroughly as in thin sections of existing plants. For the most part the trees and smaller plants of the Coal period were converted into coal. A mass of vegetable débris accumulated on the swampy site of a forest, and after submergence and sealing-up under superposed sediments it passed by slow degrees into more or less homogeneous coal. In a few places patches of this peaty material were petrified by the deposition of carbonates of magnesium and calcium derived from mollusc shells and so preserved as samples of the coal-forming vegetable detritus. From thin slices of these patches it has been possible not merely to glean information as to the affinities of Palæozoic plants, but to learn something at least of the conditions under which they lived. It is noteworthy that in addition to the plant-containing nodules embedded in the coal itself, others are found in the roofs of the seams, and in these are occasionally preserved pieces of stems and other organs associated with numerous marine shells. It is probable that while the fragments preserved in the nodules from the seams formed part of the débris accumulated on the actual site of the forest, those from the roof-nodules are waifs and strays drifted by sea-water from the vegetation of higher ground. It has often been stated, though without adequate reason, that the Coal period was characterised by tropical conditions. It is at least certain that the conditions were favourable to luxuriant growth, and it is by no means unlikely that the atmosphere was richer in carbon in the form of carbon dioxide than it is to-day. The flora that has left scanty records in the roof-nodules differs in certain respects from the richer flora preserved in the coal itself, and the differences are such as lend support to the view that the forests which furnished the coal-producing material grew in swampy ground, while the roof-nodule plants grew on dry land.

Before dealing with the anatomical structure of a few Carboniferous plants further reference may be made to the question of climate. It used to be asserted that in the Coal period the climate was uniform over almost the whole world. In recent years it has been shown that whatever may have been the temperature in the northern hemisphere, there is good reason for believing that in India, South Africa, South America, and Australia the climate was different. During the latter part of the Carboniferous period the vegetation of Europe, North America, and part of China was fairly uniform in composition, and these regions were also characterised by similar physical conditions. The precise correlation of rocks in widely separated localities is often difficult, but it is safe to say that in India and the southern hemisphere strata occur corresponding in geological position with Upper Carboniferous and with Permian rocks in North America, Europe, and China; these southern rocks, conveniently termed Permo-Carboniferous, contain many plants some of which are closely allied to typical northern species, while others are distinct, notably a genus known as Glossopteris, a fern-like plant, though probably a member of an extinct group intermediate in some respects between ferns and seed-plants. From the extraordinary abundance and wide geographical range of Glossopteris in South America, South Africa, India, and Australia, this southern flora is spoken of as the Glossopteris flora; it differs from the contemporaneous northern flora not only in the presence of Glossopteris and several other types unknown in the coal-fields of Europe, but in the absence of many of the most abundant northern plants. With the Glossopteris strata are associated extensive boulder beds, clearly pointing to the existence of glaciers or water-borne ice, and these beds sometimes rest on a platform of solid rock, exhibiting in its rounded outlines and smooth, grooved surfaces unmistakable evidence of moving ice. The conclusions drawn from these and other facts point clearly to the existence of two botanical provinces in the Permo-Carboniferous era, for the most part sharply contrasted, but in a few places intermingling. In the southern hemisphere, and stretching north of the equator into India, was a vast continent, occupying a large portion of what is now the southern ocean, and of this lost continent remnants are preserved in South Africa, South America, and Australia. The abundance of boulder beds and ice-scored rocks in the southern hemisphere demonstrates the prevalence of conditions favourable to the formation of glaciers, a marked contrast to the physical environment of the swamp forests north of the equator.

It is unfortunate that the plants preserved in the southern hemisphere strata are very seldom met with in a petrified state; they occur almost exclusively as casts or impressions. A few specimens of petrified stems recently received from South Africa and India, with others previously described from Australia, afford one piece of evidence bearing on the problem of climatic conditions, namely, the presence of well-defined rings of growth in the wood. Stems from Carboniferous and Permian strata in the northern hemisphere do not as a rule possess any regular rings of growth; their wood is composed of water-conducting tubes of uniform diameter denoting an absence of seasonal changes. A tree growing in a district where a period of inactivity or winter rest is succeeded by a vigorous awakening in the spring, registers the contrast by the production of large vessels in response to the greater demands on the water-supply consequent on the sudden increase of activity in the life of the plant; the production of these water-tubes of wider bore in juxtaposition to the narrower vessels formed in the previous autumn at the close of the growing period gives the appearance of an annual ring. In tropical countries similar annual rings are formed when alternating dry and wet seasons replace spring and autumn, and it occasionally happens that several rings are produced in one year. An extreme case is afforded by a tree of *Theobroma cacao,* the cocoa tree, planted in Ceylon in the summer of 1893, and felled in January, 1901, in which during a period just above seven years twenty-two rings were formed. In this instance the tree shed its leaves three times a year, and each break in the uniformity of its life-processes was marked by the juxtaposition of wide and narrow water-conducting tubes. In many tropical trees and in stems of some plants growing in water there are no annual rings because there are no seasonal disturbances to interfere with the even tenor of existence. As a general rule, however, the rings are annual and afford a fairly accurate measure of age. The occurrence of well-marked rings in the South African and Indian stems of Palæozoic plants is therefore of some interest as an indication of regularly recurring seasons in contrast to the more uniform conditions characteristic of the more or less contemporary northern flora. Petrified stems from Jurassic, Cretaceous, and Tertiary rocks in the northern hemisphere usually show well-defined rings of growth.

An interesting illustration of the employment of the relative breadth of concentric rings of growth in trees as a guide to climate is given in a recent paper by Mr. E. Huntington in a Smithsonian Report for 1912. This author, from observations made in the drier regions of Central Asia and other countries, was led to the conclusion that during the last 3000 years there were periods characterised by a greater amount of moisture, the climatic changes being of a fluctuating kind. He afterwards extended his observations to California, Arizona, and New Mexico, where ruins of prehistoric settlements afforded evidence of less arid conditions than now prevail. Evidence derived from different sources points to the occurrence of three main periods of relative prosperity in both the eastern and western hemispheres. To test this hypothesis an examination was made of the growth-curve of certain forest trees in relation to the rainfall during the last forty years; this showed a close agreement and justified the use of the measurement of rings in trees, reaching in some cases an age of more than 3000 years, as an index of external influences. A curve of growth based on the relative breadth of the rings in several stumps of old Sequoia trees showed marked pulsations which on the whole coincide with climatic changes as deduced from other data

We may next briefly consider the nature of the evidence afforded by anatomical features exhibited by petrified plants from English coal seams. One of the commonest genera in the forests of the Coal period was that known as Calamites, similar in habit to modern Horsetails, but attaining the proportions of a tree with a thick woody stem. The leaves of slender foliage shoots occasionally preserved in the calcareous nodules from the coal are characterised by palisade cells disposed radially and at right angles to the surface, an arrangement correlated with fairly bright illumination rather than dull diffused light. The structural features on the whole suggest a plant living under conditions where the output of water from the leaves was kept within prescribed limits. The roots of Calamites contain large air-spaces in the cortex similar to those in the stems and roots of recent water-plants. Another common type in the Coal-period forests was Lepidodendron, an arborescent member of a class including the existing club mosses and similar plants, which reached a height of at least 100 ft., and had the power of producing an ever-widening cylinder of wood like that of a pine or an oak. The stem rose from a dichotomously branched subterranean organ that grew to a considerable length in a horizontal position a short distance below the surface of the ground, precisely like the underground organs of plants in the partially water-logged soil of a modern fen. The leaves were well provided with stomatal pores situated in grooves on the under surface, an arrangement suggestive of life under conditions requiring economy in the expenditure of water. Certain anatomical features in the stem suggest that the tree grew in swampy soil or possibly with the lower part of the trunk immersed in water, like the plants in a tide-swept mangrove swamp. A different type of Palæozoic plant is illustrated by Lyginopteris, a remarkable generalised genus with the habit of a slender tree-fern, but agreeing with the higher plants in the possession of true seeds. The stem bore aerial roots characterised by a covering of thin-walled cells, which may have enabled these organs to absorb water from a moist atmosphere. Another extinct genus from the Coal Measures, Sphenophyllum—so called because of its wedge-shaped leaves—affords in its long and slender stem and certain anatomical peculiarities evidence of a climbing habit, and suggests a genial climatic environment. The genus Cordaites, particularly abundant in some of the French coal-fields, and met with also in English localities, resembled in habit, and to some extent anatomically, the Kauri Pine (*Agathis australis*) of New Zealand. The wood is uniform in structure and in specimens from the northern hemisphere without regular rings of growth. The long, flat leaves reveal a distribution of supporting tissue in the form of I-shaped girders as efficient mechanically as the corresponding tissue in leaves of existing plants adapted to resist the force of the wind. Groups of small lateral roots of Cordaites have been found in a petrified condition, containing in their cortex the delicate tubular cells of a fungus, and it is believed that this association of fungus and root affords an example of symbiosis, the two organisms living together to their mutual advantage. It is noteworthy that certain recent trees, such as the Alder, inhabiting swampy ground, are characterised by an association of a fungus with short fleshy roots similar to those of Cordaites, the fungus assisting the roots to absorb water from a soil rich in humic acid. It may be, therefore, that this discovery of symbiotic relationship in the roots of a Coal-period tree supplies additional evidence in favour of a swampy habitat.

Attention may now be directed to the vegetation of a more recent geological period, namely, that known as the Jurassic. Sedimentary rocks of this age are often rich in fossil plants, but as yet the present dominant class, the flowering plants, had not begun to assert itself in the struggle for existence. Jurassic floras are known from the Arctic regions, many parts of North America, Europe, and Asia, from South America, and so far south as Graham Land, also from India, China, Australia, and elsewhere. There is conclusive evidence of the almost world-wide distribution of certain plants during this period of the earth's history, and despite our imperfect knowledge of the floras, we are justified in stating that the available data afford no satisfactory evidence of any well-marked differences in the nature of the vegetation in various latitudes such as might fairly be expected had there been climatic zones comparable with those of the present era. Identical or closely allied species of Jurassic and Cretaceous age are recorded from Greenland, England, India, and Graham Land, and, so far as it is possible to base any conclusions as to climate on a comparison of these extinct plants with modern forms, they indicate an environment characteristic of subtropical or tropical regions. A remarkable example of wide distribution is afforded by some large fronds described from Lower Cretaceous rocks in Greenland by the late Oswald Heer, belonging to a class of seed-plants known as the Cycadales or Cycads, now represented by a few genera for the most part tropical in their distribution; the most northerly members of the class occur in Florida, while the great majority grow in southern countries. Fossil cycadean fronds very similar to those from the west of Greenland are common in the Jurassic plant-beds at Whitby and other localities on the Yorkshire coast, also in strata of the same age in India, Siberia, California, and many other parts of the world. A few years ago members of a Swedish expedition discovered several Jurassic plants in Graham Land (lat. 63° 15′ S.), on the edge of the Antarctic circle, among which were cycadean leaves almost identical with the slightly more recent (Lower Cretaceous) specimens from Greenland. Cycadean plants of Jurassic and Lower Cretaceous age are represented in several parts of Britain, in most cases by impressions of leaves, but sometimes, as in the Isle of Portland, by large stems and occasionally by petrified flowering shoots; the latter have supplied important information as to the affinity of these extinct members of the class, and incidentally their structure points to circumstances necessitating efficient protection against drought

By treating with acid the carbonised film that can often be detached from an impression of a fossil plant preserved in shale, it is sometimes possible to obtain a preparation of the mummified cuticle or superficial covering of a leaf suitable for microscopical examination. Such specimens furnish information as to the structure and number of the stomata, and the data may be of value as criteria of climatic conditions. The carbonised impressions of cycadean fronds from the Jurassic plant-beds of Yorkshire, recently investigated by Mr. Hamshaw Thomas, of Cambridge, furnish particularly good preparations of the resistent cuticle, the only part of the leaf that has escaped destruction, and these supply a clue not only as to systematic position but also with regard to the structure of the mechanism by which the plants regulated their output of water and gaseous exchange with the atmosphere. Although it is rash to institute a close comparison between extinct types and their nearest living representatives as regards climatic conditions, the data obtained by a study of Lower Cretaceous and Jurassic floras throughout the world point to a greater uniformity in the vegetation, and indicate the prevalence of a higher temperature in Arctic and Antarctic regions than at the present day. It has recently been stated by Dr. Gothan, of Berlin, that the comparative study of petrified wood affords evidence of seasonal changes in Arctic lands as opposed to a greater uniformity of conditions—as indicated by the absence of annual rings—in tropical regions; but the data are at present scarcely sufficient to justify any definite pronouncement as to the occurrence of climatic zones during the Jurassic period.

Our knowledge of the more recent geological periods is as yet too meagre to warrant any very precise conclusions as to their climates. The older Tertiary floras are characterised by several flowering plants closely related to modern species in subtropical and tropical countries; fossil seeds from the London clay and from beds of similar age in Belgium and practically identical with those of Nipa, a palm which flourishes in the swampy ground of tropical estuaries. As the buoyant seeds of Nipa now abound in the waters of the Ganges, the seeds of their Tertiary predecessors floated in the river by which the muddy sediments were deposited that now form the London clay. The subtropical flora of England was gradually modified and partially exterminated as the result of changes in physical conditions which culminated in the Ice age.

It has long been known that in many parts of the British coast there are exposed at low tide stretches of peaty soil containing stumps of forest trees; these submerged forests, or Noah's Woods as they have been locally named, in reference to their supposed connection with the Deluge, point to a higher level of the land subsequent to the Glacial period. It is probable that at the time represented by the oldest submerged forest the whole of the southern part of the North Sea "was an alluvial flat connecting Britain with Holland and Denmark, and to some extent with France."[2] The prevalence of the oak indicates a mild climate: the fauna and flora as preserved in the submerged forests are described by Mr. Clement Reid as poor and monotonous, characteristic of a period of transition between the Ice age and the climatic conditions of modern times. In the alternate succession of old forest-beds and estuarine silts we have an epitome of changing level and fluctuating climates, in part at least during the Neolithic age and extending into the period when man used polished flint implements; the Arctic plants had disappeared, and at a later stage, as the climate improved, more southern species were able to establish themselves on British soil.

The testing of climate by means of fossil plants becomes easier the nearer we approach the present era; the greater the contrast between the floras of the past and those of the present the more hazardous it is to draw conclusions as to temperature. It is from a careful study of the anatomical characters of extinct plants that we are enabled to form opinions, not so much as to temperature, but as to the relation of the plants to water and light as indicated by those structural features which in recent species afford the safest index of external conditions. As our knowledge of recent plants increases and we learn more about the operation of the several factors concerned in the moulding of structure, the better able we shall be to speak with confidence as to the conditions under which they lived and extracted from the atmosphere the carbon from which we now regain the energy originally absorbed as sunlight by the green leaves of Palæozoic plants. As additional facts accumulate with regard to the geographical distribution of the plants of former ages we shall be in a better position to confirm or to modify the conclusions based on the material now available as to the comparative uniformity of climatic conditions in the Jurassic period. Much of the palæobotanist's work necessarily consists in the collection and identification of material preserved in sedimentary rocks, but one of his aims should be to acquire such knowledge of the present relation between plants and their habitats as may enable him to interpret with greater confidence the botanical records of former ages.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LORD KITCHENER has been elected rector of the University of Edinburgh by the unanimous vote of the students.

DR. SYDNEY CHAPMAN, who was elected a fellow of Trinity College, Cambridge, last year, has now been appointed to the staff of the college as lecturer in applied mathematics, and has resigned his position as chief assistant at the Royal Observatory, Greenwich. Mr. John Jackson, Trinity College, Cambridge, has succeeded him at Greenwich.

A COPY of the new issue of "The Cambridge Pocket Diary, 1914–15" has been received from the Cambridge University Press. The diary appeals especially to teachers and students in institutions of higher education, because it covers the academic year instead of following the ordinary calendar.

BY the will of the late Mr. William Gibson the sum of 10,000*l.* is bequeathed to Queen's College, Belfast, upon trust for investment and to form a "Gibson Scholarship Fund," of which the income is to be applied in the encouragement of education in agriculture by the establishment of Gibson Scholarships for resident undergraduates of the college, being sons of farmers in the counties of Down or Antrim.

THE Manchester School of Technology possesses particulars of more than 550 students who were in attendance at the college during the academic year 1913–14 and are now serving in various branches of his Majesty's forces. With a view to the completion of a roll of honour, which shall also include the names of past students engaged upon military service, the registrar will be glad to receive any information from such persons themselves or from their relatives or friends.

THE Martell Scholarship in Naval Architecture has been awarded by the council of the Institution of Naval Architects to Mr. F. J. A. Pound, H.M. Dockyard, Portsmouth, who is now proceeding to the Royal Naval College, Greenwich. The scholarship is of the value of 100*l.* per annum, and tenable for three years. The fund which is being raised in connection with the Institution of Naval Architects as a memorial to Sir William White has now reached a total of nearly 3000*l.*, and it has been decided to devote the principal part of the fund to the establishment of a scholarship for research work in naval architecture, particulars of which will be announced in due course.

IT is announced in *Science* that Baker University, Baldwin, Kan., has completed its 100,000*l.* endowment fund, of which the general education board of New York gave 10,000*l.* The rest was contributed by 10,000 persons, the largest gift from any one of them being 5000*l.* The people of Baldwin, a town of 1200 population, gave 9000*l.* Central College, Fayette, Mo., too, our contemporary says, has completed a campaign to increase the productive endowment of the college by 60,000*l.* Of this amount the general educational board contributed 15,000*l.* This fund increases the endowment of Central College to 100,000*l.* The grounds, buildings, and equipment are valued at 60,000*l.*

AN interesting indication of the effect of the war on American universities, says the *Scientific American*, is afforded in a statement given out recently from the chemistry department at Columbia University. According to that department, students who prior to the war had arranged to go to Germany to study now seek information as to the courses afforded in the United States, and it was estimated that when the University opened, the registration at Columbia in all of its departments would be materially increased through the students who cannot pursue their studies abroad. One of the courses which is especially attracting those who had contemplated a winter at the German institutions is that afforded in industrial chemistry.

THE following free Chadwick Public Lectures will be delivered in London during the months November, 1914, to January, 1915:—November 14, 21, and

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[2] "Submerged Forests." Clement Reid.

28, "Camp, Ship, and Hospital Hygiene," Dr. A. T. Nankivell; December 4 and 11, "Government and Military Sanitation in the Tropics," Sir Ronald Ross; January 15, 22, and 29, "War and Disease," Dr. F. M. Sandwith. With the sanction of the Medical Director-General of the Navy and by arrangement with the Surgeons-General of the respective ports, a course of three Chadwick Lectures on naval hygiene will be given by Prof. W. J. Simpson, at Portsmouth, on November 27 and December 4 and 11, and at Plymouth on November 28, December 5 and 12. Further particulars of these and other Chadwick Lectures may be obtained from the secretary, at the offices of the Chadwick Trust, 8 Dartmouth Street, Westminster.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 12.—Ed. Perrier in the chair.—H. **Douvillé** and M. **Couyat-Barthoux**: The massif of Moghara, to the east of the Isthmus of Suez.—André **Blondel**: New diagram of alternators with projecting poles.—B. **Jekhowsky**: The determination of the difference of longitude between London and Nice by wireless telegraphy. The radiotelegraphic method described by Claude, Ferrié, and Driencourt was employed. The difference of longitude between Paris and Nice was found to be 0h. 19m. 51·204s. ±0·06s.—E. F. **Gautier**: A Pliocene volcano at Tigri, in eastern Morocco.—Stanislas **Meunier**: The presence of chondria in caillite; consequences for the mode of formation of the meteoric irons.

CAPE TOWN.

Royal Society of South Africa, September 16.—Dr. L. Péringuey, president, in the chair.—A. E. V. **Zealley**: The great dyke of norite of southern Rhodesia: petrology of the Selukwe portion. The well-known great dye of southern Rhodesia extends for some 300 miles throughout the territory, and has a width of outcrop of about four miles. It has usually been regarded as composed of ultra-basic rocks, such as picrite. The author, however, takes the view that it should be termed a dyke of norite.—H. A. **Wager**: The Mosses of South Africa. The author gives a catalogue which he states is the first attempt that has been made of publishing a list of the Mosses already recorded from South Africa, except for a small catalogue of the Mosses of Cape Colony published by J. Shaw in 1878.—T. F. **Dreyer**: A Mesostoma from Bloemfontein (*M. karrooense*, n. sp.). A description is given of this new species of worm obtained from a small temporary pond on clay soil, which is always contaminated with cattle droppings.—Dr. T. **Muir**: Note on Hesse's generalisation of Pascal's theorem. The purely geometrical theorem known as Pascal's was investigated by Cayley and others as a theorem in *co-ordinate* geometry, and Hesse, in doing so, had the good fortune to employ certain identities which he saw to be capable of a wider application, and thus to lead to a generalisation of Pascal's geometrical result. The present paper extends the said identities and seeks to place them in their natural relation to others of importance in a different domain.—H. **Bayon**: Herpetomonidæ found in *Scatophaga hottentota* (Diptera) and *Chamaeleon pumilus* (Lacertilia). Descriptions are given of flagellate protozoa found as parasites in the common "blind-fly" on Robben Island and in the chamæleon. Though slight differences in size and appearance are noticeable in these Herpetomonads from different sources, still they certainly are not more marked than those found in samples taken from the same artificial culture of Leishmania at a few days' interval; therefore it does not seem advisable at the present stage of our knowledge to postulate two distinct species of protozoa. It does not seem excluded that a chamæleon can get infected through swallowing a fly containing Herpetomonidæ in its gut.

BOOKS RECEIVED.

Board of Education. Regulations and Syllabuses for Examinations in Science and Technology, 1915. Pp. vi+85. (London: H.M.S.O.; Wyman and Sons, Ltd.) 3*d*.

A Contour Map of Scotland. Mounted to hang on wall, with rollers, and varnished, or mounted, cut to fold, with eyelets. (London: G. W. Bacon and Co., Ltd.) 16*s*.

University of London. University College Calendar. Session MDCCCCXIV–MDCCCCXV. (London: Taylor and Francis.)

Preliminary Practical Physics. Part ii. Heat. By A. E. Lyster. Pp. vii+73. (Dublin and Belfast: Educational Company of Ireland.) 7*d*.

A Text-book of Chemistry. By W. A. Noyes. Pp. xv+602. (London: G. Bell and Sons, Ltd.) 8*s*. 6*d*. net.

Behavior: an Introduction to Comparative Psychology. By Prof. J. B. Watson. Pp. xii+439. (New York: H. Holt and Co.) 1.75 dollars.

Essentials of College Botany. By Profs. C. E. and E. A. Bessey. Pp. xiv+409. (New York: H. Holt and Co.) 1.50 dollars.

Biology. By Prof. G. N. Calkins. Pp. viii+241. (New York: H. Holt and Co.) 1.75 dollars.

Henri Bergson: an Account of his Life and Philosophy. By A. Ruhe and N. M. Paul. Pp. vii+245. (London: Macmillan and Co., Ltd.) 5*s*. net.

The Coco-Nut. By Prof. E. B. Copeland. Pp. xiv+212. (London: Macmillan and Co., Ltd.) 10*s*. net.

Forty-fourth Annual Report of the Deputy-Master and Comptroller of the Mint, 1913. Pp. 227. (London: H.M.S.O.; Wyman and Sons, Ltd.) 1*s*.

Records of the Survey of India. Vol. v. Reports of the Survey Parties for 1912–13. Prepared under the direction of Col. Sir S. G. Burrard. Pp. ii+171+maps. (Calcutta: Superintendent Government Printing, India.) 6*s*.

Memoirs of the Indian Museum. Vol. iii., No. 4. An Account of the Oriental Passalidæ (Coleoptera) based primarily on the Collection in the Indian Museum. By F. H. Gravely. Pp. 177–353+plates xi.–xiii. (Calcutta: Baptist Mission Press.) 5 rupees.

Through Siberia, the Land of the Future. By Dr. F. Nansen. Translated by A. G. Chater. Pp. xvi+478. (London: W. Heinemann.) 15*s*. net.

Jahrbuch des Norwegischen Meteorologischen Instituts für 1913. Pp. xii+139. (Kristiania: Gröndahl und Sön.)

Nedbøriagttagelser i Norge utgit av Det Norske Meteorologiske Institut. Aargang xix, 1913. Pp. xi+65. (Kristiania: H. Aschehaug and Co.) 3.00 kroners.

The Electron Theory of Matter. By Prof. O. W. Richardson. Pp. vi+612. (Cambridge University Press.) 18*s*. net.

School Electricity. By C. J. L. Wagstaff. Pp. xi+250. (Cambridge University Press.) 5*s*. net.

The Cambridge Pocket Diary, 1914–1915. Pp. xv+255. (Cambridge University Press.) 1*s.* net.

Berkeley and Percival. By B. Rand. The Correspondence of George Berkeley, afterwards Bishop of Cloyne, and Sir John Percival, afterwards Earl of Egmont. Pp. x+302. (Cambridge University Press.) 9*s.* net.

The Map and its Story: A Physical Atlas. Pp. 44. (London: G. W. Bacon and Co., Ltd.) 1*s.* net.

The Philosophy of Change: a Study of the Fundamental Principle of the Philosophy of Bergson. By H. Wildon Carr. Pp. xii+216. (London: Macmillan and Co., Ltd.) 6*s.* net.

Macmillan's Reform Arithmetic for Rural Schools, for Upper Classes (Standards V.–VII.). By P. Wilkinson and F. W. Cook. Pp. 80. (London: Macmillan and Co., Ltd.) 5*d.*

Elementary Mathematical Analysis. By Prof. C. S. Slichter. Pp. xiv+490. (New York and London: McGraw-Hill Book Co., Inc.) 10*s.* 6*d.* net.

Bartholomew's Reduced Survey Map of N.E. France, Belgium, and the Rhine (Edinburgh: J. Bartholomew and Co.) 2*s.* net.

Flintshire. By J. M. Edwards. Pp. xi+172. (Cambridge University Press.) 1*s.* 6*d.* net.

The Counties of Peebles and Selkirk. G. C. Pringle. Pp. x+149. (Cambridge University Press.) 1*s.* 6*d.* net.

The Annual of the British School at Athens. No. xix. Session 1912–13. Pp. viii+314+plates. (London: Macmillan and Co., Ltd.) 25*s.* net.

The Chemical Examination of Water, Sewage, Foods, and other Substances. By J. E. Purvis and T. R. Hodgson. Pp. 228. (Cambridge University Press.) 9*s.* net.

Bird Biographies and other Bird Sketches. By O. G. Pike. Pp. 180. (London: Jarrold and Sons.) 6*s.* net.

The Romance of the Beaver. By A. R. Dugmore. Pp. xiv+225. (London: W. Heinemann.) 6*s.* net.

Concerning Animals and other Matters. By E. H. Aitken ("EHA"). Pp. x+196. (London: J. Murray.) 6*s.* net.

The University of Sheffield. Calendar for the Session 1914–15. Vol. i. Pp. 714. (Sheffield University.)

Viśvakarmá: Examples of Indian Architecture, Sculpture, Painting, Handicraft. Chosen by Dr. A. K. Coomaraswamy. First series. Pp. 31+plates 98. (London: Luzac.) 4*s.*

Examples and Test Papers in Algebra. By W. J. Walker. Parts ii. and iii. Pp. viii+163–338. (London: Mills and Boon, Ltd.) 1*s.* 3*d.*

Assaying in Theory and Practice. By E. A. Wraight. Pp. xi+323. (London: E. Arnold.) 10*s.* 6*d.* net.

A History of Botany in the United Kingdom from the Earliest Times to the end of the Nineteenth Century. By Dr. J. R. Green. Pp. xii+648. (London: J. M. Dent and Sons, Ltd.) 10*s.* 6*d.* net

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 29.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address by the President.

CHILD STUDY SOCIETY, at 7.30.—After Care of Mental Defectives: Miss E. Fox.

FRIDAY, OCTOBER 30.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Thomas Hawksley Lecture: Pumping and Other Machinery for Waterworks and Drainage: W. B. Bryan.

SATURDAY, OCTOBER 31.

ESSEX FIELD CLUB (at the Essex Museum of Natural History, Stratford), at 6.—The Evolution of the Essex Stour: G. H. Boswell.—Note on a Fossiliferous Exposure of London Clay at Chingford: A. Wrigley.

MONDAY, NOVEMBER 2.

SOCIETY OF ENGINEERS, at 7.30.—Uses of the Hydraulic Mining Cartridge: J. Tonge.

TUESDAY, NOVEMBER 3.

RÖNTGEN SOCIETY, at 8.15.—Presidential Address: Sir Alfred Pearce Gould.

INSTITUTION OF CIVIL ENGINEERS at 8.—Inaugural Meeting of the Session. Presidential Address: B. Hall Blyth.

WEDNESDAY, NOVEMBER 4.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Addition of Foreign Substance to Flour, with Special Reference to Persulphates: A. R. Tankard.—(1) Note on Bleached and Unbleached Flour; (2) Methyl Red as an Indicator: R. T. Thomson.—Two Rapid Methods of Estimating Water in Crude Petroleum, Oil Fuel and Similar Substances: H. S. Shrewsbury.—Note on Vinegar: J. S. Jamieson.

GEOLOGICAL SOCIETY, at 8.—The Inferior Oolite and Contiguous Deposits of the Doulting-Milbourne-Port District (Somerset): L. Richardson.—Some Inferior Oolite Pectens: E. Talbot Paris and L. Richardson.

ENTOMOLOGICAL SOCIETY, at 8.—The Larva of *Polyommatus zephyries* var. *lycidas*: Dr. T. A. Chapman.

THURSDAY, NOVEMBER 5.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Luminous Vapours Distilled from the Air, with Applications to the Study of Spectrum Series and their Origin, II.: Hon. R. J. Strutt.—The Production of Neon and Helium by the Electrical Discharge: Prof. J. N. Collie, H. S. Patterson, and I. Masson.—The Flow of Viscous Fluids through Smooth Circular Pipes: Prof. C. H. Lees.—Quantitative Measurements of the Absorption of Light. I.: The Molecular Extinctions of the Saturated Aliphatic Ketones: F. O. Rice.—The Ignition of Gases by Condenser Discharge Sparks: Prof. W. M. Thornton.—The Spark Spectrum of Nickel under Moderate Pressures: E. G. Bilham.

CHILD STUDY SOCIETY, at 7.30.—Classification of the Deaf Child for Educational Purposes: P. M. Yearsley.

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THURSDAY, NOVEMBER 5, 1914.

DAIRY CHEMISTRY AND DAIRY CONTROL.

Dairy Chemistry: A Practical Handbook for Dairy Chemists and others having Control of Dairies. By H. D. Richmond. Second edition, revised. Pp. xi+434. (London: Charles Griffin and Co., Ltd., 1914.) Price 15*s*. net.

THE first edition of this book has been out of print a good number of years now, and many inquiries must have been made for the new edition of "Richmond." This second edition will therefore be welcomed by a large section of those who are interested in dairying, for the information it gives is difficult to obtain elsewhere.

The main arrangement of the new edition is similar to what it was before, and it would not be easy to improve upon much of the subject-matter. In the first chapter, for example, there is a particularly clear account of the constituents of milk, and sufficient detail of the chemistry of the constituents is given to satisfy any inquirer. Following upon this chapter comes one which deals with the analysis of milk, and here are given in detail the various methods of determining the specific gravity and the formulæ for calculating the total solids, etc. The milk scale is also explained very fully. Attention may here be directed to the author's water oven, which appears to be admirably adapted to the drying of milk samples if a vacuum drying apparatus is not available.

The quantitative methods for the estimation of boric acid and of milk sugar are given, and also the gravimetric and volumetric methods for the estimation of fat. Additional matter in this chapter deals with the acidity of milk and the method employed for indirectly estimating the proteins by means of the aldehyde figure.

The analysis of sour milk is dealt with very fully and also the methods for the examination of milk powders, which are now coming on to the market in increasing quantities. The chapter on the variation in the composition of milk calls for no special remark, except that the paragraph upon the influence of feeding, etc., upon the composition of milk puts very clearly before the reader what is known upon the subject. Those paragraphs that deal with the composition of condensed milk and milk powders will be found very useful for reference. There is also a great deal of useful information contained in the chapter upon the chemical control of the dairy, and by means of it the chemist ought to have no difficulty in checking the milk as it comes into the dairy and ensuring that it leaves, whether as milk or some other product, in a pure, clean form.

The determination of the fat percentage of milk by centrifugal methods (Gerber and Leffman Beam) is gone into very fully, and much practical advice is given.

A dairy chemist must also be something of a bacteriologist, and there is a chapter devoted to this side of his work. The outline of the chief bacteria in connection with milk and the methods of making nutrient media will be found useful. In view of the fact that some authorities place considerable reliance on the reductase and fermentation tests, a little more detail of the manner in which these tests are made would have been helpful. Both these tests can be carried out rapidly, and once the operator has accustomed himself to them and taken due precautions, they serve to give many valuable indications of the cleanliness or contamination of the milk.

The chapter on butter is excellent, all the chief methods of analysis being given in detail. For comparative purposes a brief account of the manufacture of margarine would have been useful. There has not been much alteration in the chapter on cheese and other milk products, but Van Slykes' method for the estimation of products of ripening, which looks as though it would become a standard, is given. The last chapter deals with the calibration of apparatus, and if some of the juniors in every laboratory were set to calibrate the burettes, pipettes, etc., it would be an excellent training and would show how inaccurate much of the cheap glassware is.

GEOLOGICAL BOOKS FROM AMERICA.

(1) *Introductory Geology.* A text-book for Colleges. By T. C. Chamberlin and R. D. Salisbury. Pp. xi+708. (New York: Henry Holt and Co., 1914.) Price 2 dollars.

(2) *Engineering Geology.* By Prof. H. Ries and Prof. T. L. Watson. Pp. xxvi+672. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 17*s*. net.

(1) THIS is essentially an abridged edition of the "College Text-book of Geology," published five years ago, and is perhaps the most readable of the volumes contributed to geological literature by these two distinguished American teachers. In the process of concentration they have avoided a jejune presentation of their subject, the treatment being interesting throughout. A vivid sense of the out-of-doors aspect of geological study is given by a large number of fine illustrations of the operation of geological agencies in different parts of the world.

The first 300 pages are devoted to geological processes and materials. Here are described the work of the atmosphere, of overground and underground waters, and of snow and ice, vulcanism and the movements of the earth's crust, and the nature and arrangement of rock-types and rock-masses. The second part, of some 400 pages, deals with historical geology. This should be of great service to students, especially those outside America, by providing a generalised, but not too brief account of the stratigraphy of North America, a subject of which no very satisfactory digest has hitherto been available. A classification of geological time into five eras is adopted — archeozoic, proterozoic, paleozoic, mesozoic, and cenozoic—and the description of the first of these is preceded by a discussion of the origin and constitution of the earth on the Laplacian and planetesimal theories respectively.

This part of the book is illustrated by numerous maps, sections, and figures of fossils, most of which are good. But the eighteen full-page maps showing the outcrop, underground extent, and eroded areas of the several systems in America are so largely conjectural that it is a question whether a single geological map in colours showing the actual outcrops, as at present known, would not have been more suitable and useful in a book of this kind. Many of the sections, especially those taken from the publications of the U.S. Geological Survey, seem unnecessarily detailed, and have suffered by reduction: their educational value might have been greater if they had been redrawn in a more diagrammatic form.

The book is an admirable statement of physical and stratigraphical geology from the American point of view, and will doubtless be warmly welcomed and much used by students and general readers for many years to come.

(2) This volume is based upon the courses in geology which the authors have been giving, for some years past, to students of engineering. The scope of the work is wide, and its treatment fuller than in most books on the subject which have hitherto appeared.

Chapters dealing with the minerals of rocks, and with the occurrence and origin of the rocks themselves, are followed by one on tectonics and metamorphism, in which the importance of jointing, cleavage, folding, faulting, and other rock structures in engineering operations are fully dealt with. This is succeeded by a chapter on rock-weathering and the formation of soils. The next two deal with surface and underground waters, and here the geological principles underlying water-supply, drainage, the sinking of wells, the construction of reservoirs, etc., are thoroughly discussed. A short chapter on landslides follows, and then two on the action of waves and currents in seas and lakes, and its bearing upon coastal erosion and harbour construction. The origin and economic uses of glacial deposits are then described. The remaining chapters deal with specific materials of importance to the civil or mining engineer, such as building stone, lime, cement, plaster, clay, fuels, road foundations, and road metals; the last chapter, intended for the metal miner, consists of a short account of the general principles of ore-formation and of the geology of certain of the useful metals. This, from limits of space, is necessarily somewhat inadequate.

At the end of each chapter useful references are given to additional literature on the subject therein dealt with. The book is well illustrated, and there is a triple index referring to subjects, localities, and authors. It is undoubtedly a useful addition to what has already been written on engineering geology. It is eminently practical, and its very direct application to a great variety of engineering problems should commend it, not only to students, but also to engineers in actual practice.

C. G. C.

APPLIED ELECTRICITY.

(1) *Alternating Currents and Alternating Current Machinery.* By Prof. D. C. Jackson and Dr. J. P. Jackson. New edition, rewritten and enlarged. Pp. ix + 968. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 23*s.* net.

(2) *The Elements of Electricity.* By Prof. Wirt Robinson. Second edition. Pp. xv + 596. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 10*s.* 6*d.* net.

(1) IN its thirteen chapters, this work covers fairly thoroughly the ground suggested by its title; in most places the theoretical side is treated with at least sufficient detail, but the constructional side has also received a good share of attention. We should have liked a somewhat fuller discussion of the motor-converter, and think the time is also ripe for some mention of the Kapp and Scherbius phase advancers and of the Hunt Cascade motor. The first few chapters impressed us very favourably, and although we were somewhat disappointed with the later chapters, we consider the book a good one, which will be of service to advanced students.

From the very beginning, the authors use the complex quantity, but it is not until chapter v. that we get a full explanation of the method. This chapter is an excellent one, but should have come earlier. The numerical examples given (single-phase problems) show well the use of the complex quantity, but are scarcely sufficiently difficult to bring out any advantages for it, as the actual working is exactly the same as would be done by an intelligent student who had never heard of the Steinmetz methods. In a later chapter on polyphase circuits, other examples occur in which algebraic processes have to be carried out before substituting numerical values. In these the advantages become more obvious.

The authors do not quite attain to the standard set in their preface of "avoiding the error of presenting unnecessary formulas." On the contrary, we feel that a formula has been inserted wherever the slightest excuse for it can be found, even when the same formula has been given several times already.

The facts of nature do not depend on a particular choice of units, or, indeed, upon the existence of any units at all. It is therefore quite superfluous to introduce units into the mathematical treatment of these facts. Why will all authors not let their symbols stand for the *thing* itself, instead of for the number of times it contains some particular unit? The length of a foot-rule remains the same whether we call it "one foot," "12 inches," 30·48 . . . centimetres, or 304·8 . . . millimetres. The symbol L can just as well represent the length itself as any of these numbers, and in this way we are freed from the necessity of continually stopping to name the units to be employed, and from the irritating repetition of numbers such as 10^8, $4\pi \div 10$, 60, 746, 33,000, and so forth, which have nothing whatever to do with the laws, but arise from some particular (and unfortunate, although customary) choice of units, and thus distract attention from the real point under discussion. In the book under review, pages and pages might have been saved in this way.

Taking the book as a whole, the explanations are not as clear and concise as they might be; indeed, we found it exceedingly difficult to follow some of them. Several hydraulic analogies are given, but we are very doubtful whether these are really helpful, because the laws of hydro-dynamics have to be strained to make them fit the electrical case, and not infrequently the student's knowledge of that subject is less than of electricity.

(2) Except that part v. goes rather more fully into the technical side than is customary in books with its title, this book covers the well-worn ground of elementary magnetism and electricity. It contains little that is original in matter or in method, and its mathematics is uneven.

Many of the statements given ought to have attached to them the qualifying conditions under which alone they are true. Parts of the book are painfully laboured over some small point, while others are extremely superficial and betray a lack of insight into the true inwardness of the matter discussed.

In our science we have many traditions and dogmas from which we must ultimately break loose, and the sooner this is recognised by the writers of elementary text-books the better it will be for our students. What was best half a century or more ago is not necessarily even good now. Consider the electrostatic and electromagnetic systems of definitions. In chapter 39 the absurdity of the dimensional relations which arise from these definitions is pointed out; but in the other chapters which form the real book, we still have the old Gauss system omitting μ and κ. Why not omit the electrostatic system altogether? The sum total of our loss would be a fund of examination questions and a source of confusion as to what is intended when one of our most prominent physicists tells us that the charge of an electron is so many "units." The dielectric constant (we object to our author's "dielectric capacity") of air or other material would then appear to be what it really is—a thing the value of which has to be determined by experiment like its density, elasticity, or any other property.

Ohm's law, electromotive-force, and potential difference are always stumbling blocks. We should not deliberately blind our students to more than one-half of the phenomena by telling them that the current must flow from high potential to low potential; that a current must be flowing if two parts of a conductor are at different potentials; that a current cannot flow unless there is a potential difference; and that the P.D. is equal to the product of the resistance and current. When restricted to the proper cases, all these statements are quite true; but not a single one of them is always true, and the first and last are not even true in the majority of instances. We have only to consider what takes place in the battery branch of a circuit; in a homopolar dynamo; in a copper ring while a magnet is being thrust symmetrically into it, or in an ordinary electric motor, to see how badly we treat our students when we saturate them with these ideas, which they must later unlearn if they continue the subject.

In this book we have "resistance" in chapter 24, "Ohm's law" in chapter 25, and "Joule's law" in chapter 35. Surely the essential thing about resistance is that it causes a generation of heat when a current flows, and these two laws are merely different ways of looking at the same physical fact. A true understanding of electromotive force would at once show that this is the case, and that the ultimate result of both laws is that the property of a given conductor which we call its "resistance" is a constant under certain conditions.

Again, we greatly object to the common practice of dragging in Ohm's law in connection with the magnetic circuit. Since the reluctance of the iron parts is not independent of the flux, even the mathematical analogy is very imperfect. There is no *real* analogy at all, for in the magnetic case nothing flows, and there is no continual generation of heat while the flux exists. A comparison with Hooke's law about stress and strain would be much more sensible.

Bearing in mind that it is intended to be a beginners' book, and that much detail is therefore not to be expected in the more advanced and technical portions, these are really the best; indeed, the last two chapters give excellent summaries of the leading facts about the discharge of electricity through gases and about electrical oscillations.

DAVID ROBERTSON.

OUR BOOKSHELF.

Lehrbuch der vergleichenden Mikroskopischen Anatomie der Wirbeltiere. Edited by Prof. Dr. A. Oppel. VII. Teil, *Sehorgan,* by Dr. V. Franz. Pp. x+417. Price 18 marks. VIII. Teil, *Die Hypophysis Cerebri,* by Dr. W. Stendell. Pp. x+168. (Jena: G. Fischer, 1913–14.) Price 8 marks.

WE have on former occasions expressed a high opinion of the "Comparative Microscopic Anatomy of Vertebrate Animals," now appearing under the editorship of Prof. Oppel. The parts here noticed (Nos. 7 and 8) deal with the eye and pituitary body, and maintain the high standard set by the earlier parts. In systematising our present knowledge of the various forms assumed by the eye in vertebrates, Dr. Franz has utilised more than 650 papers published in recent scientific journals, and in the light of his own researches grouped a multitude of facts together, so that his text and numerous illustrations form a consecutive treatise as well as a most valuable encyclopædia for reference. He describes the minute structure of each part of the eye in turn—the retina, vitreous body, pecten, choroid, ciliary body, etc., tracing the variations undergone by each throughout the ramifications of the kingdom of vertebrate animals. The opening chapter deals with the visual cells of amphioxus; the closing one with the structure of the eye of species in which the sense of sight has been impaired or lost from disuse.

Dr. Walter Stendell's monograph on the pituitary body is of particular value at the present time. Until some thirty years ago this apparently unimportant structure was regarded as merely an interesting morphological puzzle. Our estimate was suddenly changed in 1886, when Dr. Pierre Marie discovered that the remarkable disease he described under the name of acromegaly was accompanied by a pathological enlargement of the pituitary body. It was then realised that what was supposed to be merely a small vestigial organ had a direct power of regulating and influencing the growth of the body. Embryologists, morphologists, physiologists, and pathologists then concentrated their attention on it, and the results of their labours may be seen in Dr. Stendell's pages, particularly in his long bibliographical list. We are glad to note he gives due prominence to the pioneer researches of Sir Edward Schäfer and of Prof. P. T. Herring.

Thresholds of Science. Astronomy. By C. Flammarion. Pp. xi+191. (London: Constable and Co.) Price 2*s*. net.

THE name of the author provides a guarantee of the soundness of the principles and the accuracy of the details expounded in this elementary introduction to astronomy by the eminent French astronomer. The book is essentially one for young readers, and the subject-matter is presented in a manner both lucid and interesting. The numerous illustrations are good, and aptly illustrate the text.

Commencing with the physical conditions of the earth, its motion and the resulting phenomena are treated at length, special attention being paid to the functions of the sun. A survey of the heavens with the constellations follows, and our relation to the "fixed stars" is made plain. The members of the solar system are treated individually, and their relations to each other in the system are efficiently illustrated. While dealing with the moon M. Flammarion introduces an interesting feature in a revue of the various mythical "Journeys to the Moon." The book concludes with a brief discussion of comets, nebulæ, and star clusters.

Although, as we are told in a footnote, "M. Flammarion naturally uses French measures" throughout the book, and the equivalents of the kilogram and kilometre are given, it would probably have been better had our own system of units been employed. The exercise in mental arithmetic required to obtain an estimate of the magnitude involved is very liable to break the continuity of thought, especially among the class of readers for whom the book is intended.

Bacon's New Contour Wall Map of Scotland. Scale, 1 :316,800, or 5 miles to one inch. Size 48 by 60 in. (London: G. W. Bacon and Co., Ltd.) Price 16*s*.

THIS new edition of a well-known wall map will be welcomed in schools. It is drawn on a conical projection with true meridians of longitude and errorless parallels 55° 30′ and 58° north latitude. The main orographical features are shown in the familiar shades of green and brown, and sea depths in blue tints. The lettering is such that it does not interfere with the scheme of colouring, and the railways, which are shown in red, are easily followed. The map can be obtained mounted and varnished with rollers to hang on the wall, or mounted with eyelets and cut to fold.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Faraday's Views on Catalysis.

AT the present time much attention is being given, both by chemists and by physiologists, to the mechanism of catalysis in heterogeneous systems. The interest of the question to physiologists is in connection with the mode of action of those catalysts produced by living organisms; these are called, for convenience, "enzymes."

The extraordinary insight shown by Faraday into the nature of the various phenomena with which he had to deal is well known and needs no further comment. But, on this ground, the paper which he published in the Philosophical Transactions of the Royal Society for the year 1834, entitled "On the Power of Metals and other Solids to Induce the Combination of Gaseous Bodies," deserves more consideration by modern investigators than it usually receives. The paper is also to be found in "Experimental Researches in Electricity" (vol. i., pp. 165–94), and the references given to quotations below refer to the numbered paragraphs in that reprint.

Although Faraday's work was published before the introduction by Berzelius of the name "catalysis," the combination of oxygen and hydrogen gases brought about under the influence of platinum and other solids, which is the subject of the paper before us, is clearly a case of this kind. In fact, the action of spongy platinum is given by Berzelius himself in illustration of the phenomenon.

The chief experimental fact of importance to the theory of the process, and demonstrated by Faraday in a number of different ways, is that the only condition necessary is the *perfect cleanliness of the surface* of the platinum (617). He points out that impurities of various kinds are readily condensed on the surface ("adsorbed," as we should say), from the air and even from ordinary distilled water. The presence of such films prevents that condensation of the gases which is requisite for their combination. In whatever way—mechanical, as by rubbing with polishing powders (591, 592, 593); chemical, by treatment with concentrated mineral acids (600); or by heat (596)—these substances are removed, the platinum is made active. Of special interest is the fact that making it either anode or kathode in dilute sulphuric acid (588) is particularly effective, the formation of "nascent" oxygen on the surface in the former case being the more powerful, as would be expected. The difference between the clean surface and the dirty surface is shown by the way in which water, or gases developed on the surface by electrolysis, enter into closer contact with the clean surface and form uniform films, instead of drops or bubbles.

It is pointed out in paragraph 617 that the intervention of electrical forces is excluded by the fact that both anode and kathode are active. Chemical reaction between the platinum and oxygen is also excluded by the fact that nitrous oxide and hydrogen are caused to combine (572). In paragraph 618 further evidence that the effect is not due to the intervention of platinum in a purely chemical way is given by the fact that "the effect is evidently produced by most, if not all, solid bodies."

The reader will probably call to mind that it has been held by some observers that this and similar activities shown by platinum are to be explained by the formation of intermediate compounds of the nature of oxides of platinum. The actual existence of such compounds has never been demonstrated, and the hypothesis did not commend itself to the acute mind of Faraday, whose explanation is of much interest. On account of the importance of the question I will quote the actual words used:—"They" (the phenomena under discussion) "are dependent upon the *natural conditions* of gaseous elasticity, combined with the exertion of that attractive force possessed by many bodies, especially those which are solid, in an eminent degree, and probably belonging to all; by which they are drawn into association more or less close, without at the same time undergoing chemical combination—and which occasionally leads, under very favourable circumstances, as in the present instance, to the combination of bodies simultaneously subjected to this attraction" (619). As we might put it now, gases are condensed on surfaces, losing thus the kinetic energy of their molecules, and, if capable of combining together, may be thus caused to do so. Could we have a clearer statement of adsorption and the part played by it in catalysis?

In further illustration of this "adsorption," Faraday proceeds to give some interesting examples of the condensation of water vapour and of air on the surface of various powders and on glass, pointing out in the latter case that there is no chemical affinity between air and glass. We note also that Faraday says that the vapour is condensed *upon* the substances. Again, "The gases are so far condensed as to be brought within the action of their mutual affinities at the existing temperature" (630), and "The platina is not considered as causing the combination of any particles with itself, but only associating them closely around it; and the compressed particles are as free to move from the platina, being replaced by other particles, as a portion of dense air upon the surface of the globe, or at the bottom of a deep mine, is free to move, by the slightest impulse, into the upper and rarer parts of the atmosphere" (631). As regards the adsorption of other substances on the platinum, we read: "In fact, the very power which causes the combination of oxygen and hydrogen, is competent, under the usual casual exposure of platina, to condense extraneous matters upon its surface, which, soiling it, take away for the time its power of combining oxygen and hydrogen by preventing their contact with it" (632). We have here analogous phenomena in the action of enzymes, where an easily adsorbed substance, such as saponin, prevents the action of the enzyme by obtaining possession of the surface itself and thus excluding the condensation of the molecules between which chemical action is to be brought about.

Although Faraday evidently regards condensation on surfaces as especially applicable to gases, it is clear that he considers the phenomenon to be of general occurrence. He does not appear to have met with cases of adsorption of substances from solution in liquids, but he says "an analogy in condition exists between the parts of a body in solution and those of a body in the vaporous or gaseous state" (657). Is this statement to be looked upon as an anticipation of van 't Hoff's theory of solutions?

I will conclude my quotations from the paper with the following, which is worth bearing in mind at the present day:—"I am convinced that the superficial actions of matter, whether between two bodies, or of one piece of the same body, and the actions of particles not directly or strongly in combination, are becoming daily more and more important to our theories of chemical as well as mechanical philosophy. In all ordinary cases of combustion it is evident that an action of the kind considered, occurring upon the surface of the carbon in the fire, and also in the bright part of a flame, must have great influence over the combinations there taking place" (656). The last sentence is interesting in connection with the work of Prof. Bone on surface combustion.

It is, perhaps, rather to be wondered at, since Faraday had gone so far in the interpretation of the phenomena, that he did not take the further step and bring them into relation with surface tension, to which Thomas Young had already directed attention.

In the application of these facts to the theory of enzyme action, the view was first definitely put forward by myself, so far as I know, in a paper in the *Biochemical Journal*, vol. i. (1906), pp. 222–27, that the "combination" between an enzyme and its substrate is of the nature of an adsorption. This view has received more and more support from work done by various investigators since that time. To mention one fact only, it has been found in the cases of several different enzymes that their activity is exercised in liquids in which they are completely insoluble, so that it must be the surface of the particles which is concerned. We know also that, in water, enzymes in general are in the colloidal state, a state in which chemical reactions obey laws which interfere with that of mass action in its simple form.

It is very doubtful whether intermediate compounds of a chemical nature play any part in catalysis by enzymes. None, at all events, have been shown to exist. Moreover, such an explanation is of very rare application to catalysis of any kind. The hypothesis of the action of enzymes which is most in agreement with all the facts known at present may be stated somewhat as follows: the molecules which are to enter into reaction are condensed by adsorption on the surface of the colloidal particles of the enzyme and their final state of equilibrium is brought about at a greatly accelerated rate. Whether, as Faraday seems to hold, the close approximation, and high concentration, is in itself sufficient to account, by mass action, for the increased rate of reaction is a matter for future investigation. It may well be, as Hardy points out (Proc. Roy. Soc., vol. lxxxviii. B, pp. 174 and 175), that it is in the actual process of condensation itself that the molecules are subject to stresses which result in exceptional chemical activity; their chemical potential may very well be raised in the process. It appears to be a phenomenon of very general occurrence that it is in the very act of change of state that special activities are manifested. This is particularly obvious in living organisms, where a system in equilibrium is dead, but it applies also to non-vital systems.

I would finally point out that it should not be stated that the action of enzymes does not obey mass action. Mass action is universal in its application; but, in heterogeneous systems it is controlled by other factors, such as diffusion and surface adsorption, the latter factor playing the chief part in the velocity of reaction in micro-heterogeneous systems, such as those of colloids. The rate of the reaction is conditioned by the relative masses of the molecules condensed on the surface at any one moment of time. It will be seen that the difficulty of applying the law of mass action consists in the determination of the real active masses.

W. M. BAYLISS.

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Tidal Friction and Ice Ages.

A CAREFUL study of the conditions of land height during the earlier stages of the Quaternary glacial period seems to show that the earth was then less oblate, *i.e.* the north and south polar regions stood higher than now, to the extent of as much as 10,000 ft. in places, while the equatorial regions stood lower, by some 500 ft. The spreading of ice-sheets from these high lands may well have been the initial cause of the cooling which produced the Glacial epoch.

Going further back in geological time, we find, as is well known, a series of long periods of epeirogenetic movement alternating with long periods of marine transgression. The last great change seems to have been continuous from Carboniferous times, with a girdle of land round the equator high enough to be heavily glaciated, through Mesozoic times, with a marine transgression, to Pliocene times, when the high land emerged at the poles.

Qualitatively, at least, it seems possible to read the late Sir G. H. Darwin's theory of tidal friction into these changes. By that theory, owing to the differential attraction of the moon on the tidal protuberances, the rotational momentum of the earth is gradually decreasing. This decrease may manifest itself in two ways, either by an actual decrease in the rotational velocity, or by a decrease in oblateness, *i.e.* by a movement of matter towards the poles.

It is probable that the earth's crust has a certain tendency to slide on its nucleus, and since the effect of tidal friction is chiefly felt in the crust, while the bulk of the momentum must lie in the heavy nucleus, it follows that the effect of tidal friction must be to tend to slide the crust round the nucleus parallel with the equator. As the crust must vary both in thickness and in the closeness with which it is attached to the nucleus, this means a thrust against the deeper and more closely attached portions. The thrust would tend to force some of the crust poleward on either side from the equator, *i.e.* to decrease the equatorial bulge.

But the friction between crust and nucleus is very great, and must in time result in an appreciable decrease in the angular velocity of the latter. Probably the action takes place in alternating steps—periods of constant rotational velocity, combined with a gradual thrusting of the crust poleward from the equator, alternating with periods of stability of the crust and gradual decrease in the rotational velocity. The former are periods of earth movement, mountain forming, and disturbance, resulting in the gradual deepening of the ocean over the equator and emergence at the poles; the latter are associated with a slow retirement of the ocean towards the poles, resulting in marine transgressions in middle and higher latitudes.

I have been able to accumulate a great deal of evidence which supports the theory I have outlined above on the geological side. I am, however, not sufficiently a mathematician to be able to satisfy myself that the cause, tidal friction, is commensurable with the effects, and I am begging the publicity of your columns to ask if someone better situated will help me in that respect.

C. E. P. BROOKS.

"Homeleigh," 3 Roseleigh Avenue,
Highbury, N., October 10.

AT the Editor's request I contribute a few remarks on Mr. Brooks's letter. The suggestion that tidal friction might be a cause of changes in the distribution of land and water is not new. It will be found in a "Note" in NATURE of April 25, 1889 (vol. xxxix., p. 613), where it is attributed to M. A. Blytt; and that may not be its first appearance. The character of the changes is that indicated by Mr. Brooks, but the mechanism by which they are effected is a little different. The hypothesis of a crust riding more or less freely on a nucleus is unnecessary, and difficult to reconcile with well-established results. Again, the frictional stresses do not operate directly to cause a flow of material towards or away from the poles, but indirectly by diminishing the speed of rotation.

The mechanical process may be followed very easily without any mathematics. The surface of the ocean, apart from waves and tides, is at any time a figure of equilibrium answering to the speed of rotation at the time, more oblate when the speed is greater, less oblate when it is slower. Let us imagine that the lithosphere also is at some time a figure of equilibrium answering to the speed of rotation at that time. If the speed remained constant, the lithosphere would retain this figure, and the matter within it would remain always in the same configuration without having to support any internal tangential stress. Now suppose that the speed of rotation gradually diminishes. The surface of the ocean will gradually become less and less oblate. The lithosphere also will gradually become less oblate, but not to such an extent as to make it a figure of equilibrium answering to the diminished speed of rotation, while the matter within it will get into a state of gradually increasing internal tangential stress. The effect on the distribution of land and water will be that the depth of the ocean will gradually diminish in lower latitudes and increase in higher latitudes, the latitudes of no change being 35° 16′ N. and S.

The internal tangential stress in the matter within the lithosphere may increase so much that it can no longer be supported. If this happens a series of local fractures will take place, continuing until the lithosphere is again adjusted much more nearly to a figure of equilibrium, which will be less oblate than the original figure. The effect on the distribution of land and water will be that the depth of the ocean will increase rather rapidly and spasmodically in lower latitudes and diminish in higher latitudes.

Accordingly the kind of geological change which the theory of tidal friction would lead us to expect is a sort of rhythmic sequence, involving long periods of comparative quiescence, marked by what Suess calls "positive movements of the strand," in the higher latitudes, and "negative movements" in the lower, alternating witih comparatively short periods of greater activity, marked by rise of the land around the poles and subsidences in the equatorial regions. It is for geologists to say whether the facts known to them are consistent with this description or not.

A. E. H. LOVE.

The Age of a Herring.

IN the issue of NATURE for September 17 Prof. D'Arcy Thompson states that he is unable to persuade himself of the validity of Dr. Hjort's conclusions based upon the methods of determining the age of herrings by a study of their scale-rings.

It is, of course, impossible to attempt to deal in a few words with all the evidence brought forward in favour of these methods in recent years by different biologists, and we must, with regard to the herring, refer to our published papers,[1] where arguments are given in favour of the primary assumption that the age of a herring may be determined by counting the rings seen on its scales. The facts supporting this assumption are briefly:—

(1) For young individuals (up to age of three years) the results of age determinations by means of the scale-rings correspond with the results obtained by plotting frequency curves for the length measurements of the individuals.

(2) Scale examination of small herrings continued with short intervals during all seasons showed that the formation of the so-called winter rings took place during the winter, while the formation of the so-called summer belts commenced in the spring and continued during the summer months. That the summer belt is small at the commencement of the formation in May, while it is large on the completion of the formation in the beginning of autumn, has been proved by observations carried on during four years. Regarding the older fish, it has been difficult to proceed in the same manner as for younger fish, as the frequency curves fail to give any hints as to the age groups represented in a sample, while, on the other hand, the fishing season for the old herrings does not extend over all seasons of the year. The following facts point to the correctness of the assumption that the conditions here are strictly homologous to the conditions as regards the younger fish.

(3) Among the Norwegian herrings a great many individuals had an abnormally small third summer belt on their scales. Herrings showing this abnormality have been very frequently observed during all the years from 1907 to 1914, but while the scales of these herrings in the year 1907 had only one summer belt outside the abnormal one in 1908, they showed two summer belts, and so on until the winter 1913–14, when they had seven summer belts outside. Thus these herrings, so easily distinguishable by their abnormality, have during the seven years of observation annually formed one summer belt on their scales, each belt being separated by a winter ring from the preceding and succeeding belts.

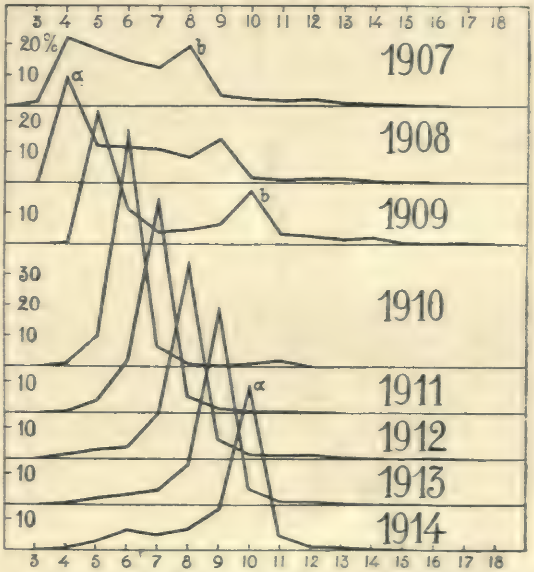

FIG. 1.—Showing the captures of Norwegian mature herrings for eight successive years, arranged in percentage frequency curves according to the number of rings on the scales (the numbers along the abscissa denoting the ring groups).

(4) By scale investigations on the Norwegian spring herrings (spawning herrings), carried out during the years from 1907 to 1914, results are obtained the main points of which are given in Fig. 1. This diagram is based upon all the material from 1907–13, while for 1914 part of the material was not worked up when the diagram was constructed (still the curve for this year is based upon more than 2000 individuals).

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[1] Hjort. "Report on Herring Investigations until January, 1910," *Publ. de Circonst.*, No. 53. Copenhagen, 1910.

Hjort and Lea, "Some Results of the Internat. Herring Inv., 1907–11. *Publ. de Circonst.*, No. 61. Copenhagen, 1911.

Hjort, "Fluctuations in the Great Fisheries of Northern Europe," *Rapports et Procès-Verbaux*, vol. xx. Copenhagen, 1914.

Lea, "On the Methods used in the Herring Investigations," *Publ. de Circonst.*, No. 53 Copenhagen, 1910.

Lea, "A Study on the Growth of Herrings." *Publ. de Circonst.*, No. 61. Copenhagen, 1911.

Lea, "Further Studies concerning the Methods of calculating the Growth of Herrings," *Publ. de Circonst.*, No. 66. Copenhagen, 1913.

The diagram shows, for each year of observation, the percentage frequency of the individuals according to the number of rings on their scales, the figures along the abscissæ denoting the number of rings, while the corresponding ordinates denote the percentages of all the individuals falling in each ring group.

The most prominent feature of this diagram is the regular movement of the primary mode (*a*) from 1908–14, as well as of the secondary mode (*b*) from 1907–09.

While in 1908 the individuals having 4 rings were the most numerous, in 1909 those having 5 rings, in 1910 those having 6 rings, in 1911 those having 7 rings, in 1912 those having 8 rings, in 1913 those having 9 rings, and in 1914 those having 10 rings predominate.

In the same manner the secondary mode (*b*), appearing in 1907 by the relative numerical strength of group 8, moves one class to the right for each of the years 1908 and 1909.

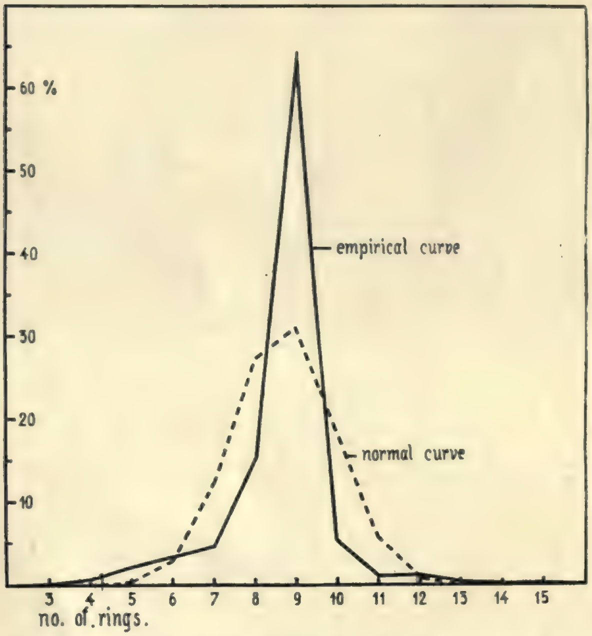

FIG. 2.—Comparison between the empirical ring curve for 1913 (in Fig. 1) and its corresponding normal variation curve.

It seems difficult to explain this regular movement of the modes, unless we assume that the two prominent modes represent two relatively abundant year-classes of herrings.

If this be true, then the material investigated leads to the conclusion that great fluctuations occur in the stock of Norwegian herrings with regard to the relative abundance of the different year-classes. That the magnitude of these fluctuations is astonishing and "very hard to imagine," is by no means an argument against the observed facts.

Prof. D'Arcy Thompson emphasises the regularity with which the so-called year-groups arrange themselves in a unimodal skew-curve, "just as the same fish group themselves also, according to size, in a unimodal but more normal curve." It seems to him "statistically improbable that a dozen separate generations of herrings, spawned in as many years, should have entered into the formation of the composite shoal in these curiously and regularly graded proportions." He finds it much easier to explain this fact by assuming that all the herrings (in a sample) were *of the same age and origin*, and that consequently the individual herrings vary about a certain modal number of rings, just as they also vary in a normal fashion about a certain modal size. He also emphasises the probability of an irregular age-curve for a population where large and irregular fluctuations occur in the annual birth-rate.

It might have been expected, then, that Prof. D'Arcy Thompson would have subjected the material published to a statistical analysis in order to convince himself of the correctness of his opinion regarding the similarity between the age-curves and the normal curves so usual in biology. He would then have found that no age-curve in the whole material of Norwegian herrings follows the usual law for biological variation. In some cases the age-curves present themselves by mere inspection as irregular (see Fig. 1, 1907, 1908, and 1909), while in other cases (when the curve is unimodal, as in Fig. 1, 1910–14) they are so entirely different from the normal frequency curve that it is totally impossible to replace the empirical curve by the corresponding theoretical one. This will be apparent from Fig. 2, giving the empirical age-curve for Norwegian herrings in 1913 (see Fig. 1) together with the normal curve for the same number of individuals, the same average and standard deviation, and the same arrangement of classes. In the following table the same data are given numerically:

Number of scale rings	Empirical frequencies in percentages	Theoretical frequencies in percentages	Difference empirical—theoretical values
3	0·1	0·0	0·1
4	0·7	0·0	0·7
5	2·2	0·4	1·8
6	3·4	3·0	0·4
7	4·8	12·5	− 7·7
8	15·4	27·4	−12·0
9	64·7	31·2	33·5
10	5·2	18·5	−13·3
11	1·2	5·8	− 4·6
12	1·3	0·9	0·4
13	0·5	0·1	0·4
14	0·2	0·0	0·2
15	0·2	0·0	0·2

The dissimilarity of the two curves is, in fact, so great as to exclude any idea of the age-curve following the usual law for biological variation. The feature that the curve is apparently unimodal, is due to the fact that one single group is so overwhelmingly abundant as to depress to a certain degree the irregularities actually existing in the frequencies of the other groups. By inspection of the age-curve for 1914 (see Fig. 1) it will be observed that the frequency of group 11, lying close to the modal group, is less than for the more extreme groups 6, 7, and 8.

For these reasons, as well as because of the regular movement of the modes, it seems to us impossible to explain the observed facts as a result of common variation, even if the help of a mathematical statistician were enlisted.

JOHAN HJORT.
EINAR LEA.

Scientific Work and the War.

DR. CALMAN's plea (NATURE, October 22, p. 198) for the continuance as usual of the work of our learned societies, or even a wider plea for the calm prosecution of all our scientific studies, may be supported on many grounds, but the only one that I wish to emphasise is the moral effect thus produced upon those neutral nations whom our opponents seek to delude into the belief that we are panic-stricken. To the reality of this effect the following sentences in a letter just received from a correspondent in Florence bear witness:—". . . e sapendo, d'altra parte, che l'Inghilterra sta fortemente sostenendo la sua bella lotta, senza perdere il tradizionale sangue freddo; per modo che la vita continua costà quasi inalterata. La regolarità, con la quale i periodici scientifici continuano ad apparire ne é la prova migliore." F. A. B.

THE CARE OF THE WOUNDED.

A FURTHER paper by Medical Inspector-General Delorme was read before the Paris Academy of Sciences on September 28, on the general subject of the treatment of wounds in war (*Comptes rendus de l'Académie des Sciences*, October 5, 1914).

The paper begins with a very welcome statement that the health of the French Army is excellent. "The persistent mildness of the weather since the war began, the extreme carefulness of the Government, the watchfulness of the Commands, from the lowest to the highest,—such fatherly watchfulness as you would not find, so intense and so alert, in any other campaign—the organisation and the regular methodical active working of the Army Medical Service, the great care given to the food-supply, the sites chosen for the troops—all these, up to now, have resulted in the maintenance of a perfect sanitary condition. The wounded Frenchman is a healthy man. Diseases are at a very low point. . . . Dysentery and typhoid are almost unknown: the proportion of cases has seemed to me to be even less than in time of peace." And, he adds, the spirit of the wounded men is perfect: it plays its great part in the work of a speedy and permanent recovery, "ce moral, qui est la traduction fidèle et tangible de la vitalité de l'homme." It is not the wounded who are broken-hearted: "le trouble n'est que dans le cœur des mères."

We are thankful to know that the general health of the French Army, and of our own Expeditionary Force, is thoroughly satisfactory. How long this blessing will last we do not know. But we may be quite certain that the Army Medical Services are working day and night for it, not in vain.

General Delorme's paper goes on to consider what more can be done for the wounded. He urges, very justly, that the large proportion of shrapnel-wounds and shell-wounds indicates the advisability of having a rather elaborate field-hospital system, as near the front as may be. Wounds of this kind, of course, are infected from the very moment of their occurrence: and it is a matter of the highest importance that they should be attended to, very thoroughly, at the earliest moment possible. The "first dressing" which may suffice for a cleaner wound, made by a bullet, will not suffice for them. The occasion may require the use of X-rays, the extraction of foreign bodies, the immediate administration of a protective serum or vaccine, and so forth: none of them to be delayed.

In the discussion of this communication the speakers were Laveran, Roux, and Landouzy; and the discussion was no less interesting than the paper. One, and that the worst, consequence of these infected wounds is, happily, under the control of a protective serum-treatment; and we may be sure that the money to provide that treatment will not be lacking. It is not simply a question of money: it is a question of what can be done, in this colossal fighting, to avoid loss of time in dealing thoroughly with so many infected wounds. As Landouzy says—and it is pleasant for an Englishman to read—"Il faut que, dans les armées des pays de Pasteur et de Lister, la Chirurgie active soit concentrée en partie et résolument vers l'avant, si l'on veut que l'asepsie et l'antisepsie des blessures de guerre soient possibles." STEPHEN PAGET.

THE TRANSIT OF MERCURY ON NOVEMBER 7, 1914.

MERCURY is one of the two planets which revolves round the sun in an orbit smaller than that of our earth, and consequently at a time of inferior conjunction generally passes just to the north or south of the sun. The reason why it does not always pass exactly between the sun and us is because its orbit is inclined at an angle of 7 degrees to the plane of the ecliptic, and the planet is only twice during a revolution at the cutting points or nodes, and is not necessarily at one of these points when passing on the near side of the sun.

When, however, conjunction does occur and the planet is near a node, it is seen to cross the sun as a small black spot, but it requires the use of a telescope to discern it. In May and November of each year the earth passes the nodal points, and it is only during these months that a transit can occur. On November 7 a very favourable transit will take place, and the whole phenomenon from start to finish will be visible from these islands during the interval comprising the two hours on each side of noon. Transits of Mercury are sufficiently rare to attract attention, as only about twelve occur in a century. The last one took place on November 12, 1907, and we shall have to wait until 1924, May 7, before another will be on view.

The planet makes first contact with the sun at 9h. 57m. 15s. on the morning of November 7 at a point on the sun's limb 156° from the north point of the sun counting towards the east. It takes the planet 2m. 14s. to place his whole disc completely on the sun. While it does not actually cross the centre of the solar disc, the time of its least distance from that centre is 12h. 3m. 22s. p.m. At 2h. 7m. 16s. p.m. the planet will have reached the sun's limb again, touching it at a point 255° from the north point, still reckoning in the same direction towards the east; it will take again 2m. 14s. to pass clear of the sun. It should be noted that the above times, although accurate enough for general observers, refer to the phenomenon as observed from the centre of the earth, and not as seen from the earth's surface.

Coming now to the method of making observations and the observations themselves, a word of warning should be given to those who are not familiar with making solar observations. No one should use a pair of binoculars or a telescope of any size unless proper precautions are taken; otherwise the loss of eyesight may be the result. It is better to make no attempt to watch the transit than to make risky observations. Proper dark glasses should be secured beforehand, and fixed firmly in position so that they cannot fall off at the critical time. A method devoid of all risk is to throw the solar image on a screen; in this way more than one observer can watch the transit.

In the *Comptes rendus* of the Paris Academy of Sciences for October 5 Monsieur Bigourdan summarises a series of the principal precautions which should be taken by those who wish to make useful observations. Such precautions are necessary because a transit of Mercury seems to be accompanied by various appearances the causes of which are not always well known. It is therefore advisable to eliminate so far as possible all possible errors which may arise through instrumental deficiencies.

He suggests first of all the method of observing the sun directly, and not by projection, for in the latter case delicate details are chiefly lost. To diminish the solar light he proposes a method of semi-silvering the outer surface of the objective, but he adds that this method holds good only when the sky is clear, otherwise observation would be impossible. The practical method of employing graduated and compensated dark glasses is chiefly recommended, and the greatest aperture of the telescope should be employed, having due regard to the heating at the focus, and the resulting cracking of the graduated glass.

While giving the preference to telescopes of large aperture, the results furnished by moderate or even small telescopes should not be neglected. Both reflectors and refractors should be brought into use. He directs attention to the importance of having diaphragms well blackened and suppressing for the time being any fixed accessories in telescopes which ordinarily serve for the illumination of the field, and which, situated in the path of the beam or in the vicinity of it would produce hurtful reflections. When an instrument can be reversed or can take up two positions successively to the right and left of its mounting, it should be utilised alternately in these positions, thus turning the whole optical system through 180°. Finally, he points out the importance of observing every appearance, however abnormal, by studying it in different positions of the telescope, with different eyepieces, dark glasses, etc. While the above precautions are particularly to be recommended for accurate observations, others of a secondary nature must not be forgotten.

With regard to the observations to be made during the planet's transit, those of first importance are the determinations of the accurate time of the internal and external contacts. Next come the measurements for the determination of the diameter and the flattening of the planet's disc. Rings (aureoles) around the black disc of Mercury form interesting objects for observation, and their intensity in relation to the neighbouring solar surface should be studied.

A spectroscopic survey of these rings would decide whether their existence was real or not, and the question of an atmosphere round Mercury could thus possibly be inquired into. Other points of interest relate to luminous appearances on the dark disc of the planet, possibility of satellites, occultations of solar spots, and faculæ by the disc, etc.

Successful observations of these and other phenomena help to further our knowledge of the movements and physical constitution of this the smallest of the planets.

A METEORITIC FALL IN LANCASHIRE

On Tuesday evening, October 13, at 8.45, the inhabitants of Lancashire and Cheshire were alarmed by a sudden and vivid illumination of the heavens caused by a ball of fire moving slowly from about S.S.E. to N.N.W. It lit up the whole countryside and consisted of several outbursts, the final one being the brightest flash. Then a short interval afterwards, the estimated periods varying from a few seconds to four minutes, according to the distances of the observers, there was a tremendous report, as though a thunder-like explosion had occurred in the region a few miles west of Wigan.

This was followed by a series of rumblings extending apparently back along the flight of the luminous object. At several places the windows are stated to have been shaken, and the vibration was such that it presented some similarity to an earthquake shock.

Numbers of persons in Manchester, Liverpool, Halifax, Northwich, Bolton, Macclesfield, and other towns witnessed the event and heard the noise, and in the present agitated state of the public mind, all sorts of ideas were formed as to the nature of the phenomenon.

A large detonating meteor had, notwithstanding the rather cloudy state of the atmosphere, not only penetrated the lower region of the air, but had resisted complete disruption and fallen to the ground. It was discovered on the following day at Appley Bridge, four miles W.N.W. of Wigan. An employee of Mr. Lyon of Halliwell Farm noticed a newly turned up mound in a field and, on examination, he saw a reddish mass of strange material lying in a hole about 18 in. below the surface. On being dug out the object weighed about 33 lbs. and in appearance looked like a rough piece of burnt iron. Subsequently, the county police took possession of the strange visitor, and it has since been handed over to the curator of the Godlee Observatory, Manchester, for proper investigation.

My preliminary discussion of the first observations received indicated that the meteor penetrated to a point so low in the air that it probably fell in the region twenty miles west of Manchester. This conclusion was mentioned in a letter to the Manchester papers, and the discovery of the meteorite a few miles west of Wigan fully justified the prediction. Several of the observers say that the object lost its luminosity when still at an apparently considerable height. This appears to show that the motion had so far slackened that combustion had visibly ceased, and the object fell to the ground in an opaque, cooling condition. Evidence of this is also furnished by its penetrating the soil to a depth of only 18 in. Several well-observed meteoritic falls have been of merely terrestrial velocity amounting to 400 or 500 ft. a second, which is something different from the velocity of 26 miles a second possessed by these bodies in planetary space. The descent of objects of this class is often vertical or nearly so, and their original velocity and direction are apparently quite changed by the new conditions impressed on them during their disruption when very near the earth's surface.

I have collected a large number of observations of the flight of the object, from which it appears that its direction was from about azimuth 335°, counted west from south, or from S.S.E. to N.N.W., and the probable radiant was at 348° + 2° in the western region of Pisces. The course of the meteor was from near Stoke to the place of its fall, a length of 49 miles traversed at a velocity of about 8 miles a second. The height declined from 29 miles to 0.

The object is said to have made a slanting hole in the ground, and this would accord with an angle of some 37°, which a radiant at 348° + 2° would indicate. But the angle of the meteor's descent must have probably become much steeper after its entry into our atmosphere as an effect of the resistance encountered and terrestrial attraction. Several disruptions of its material undoubtedly occurred before the final outburst; these reduced the size and varied the shape of the object and may well have influenced the line of flight.

The radiant in Pisces yields many fireballs in September, and one was seen by many observers on September 8 last. Daniel's comet of 1907 has an orbit which approaches near the earth's orbit on September 12 and may possibly be responsible for some of the large meteors observed in September and at a later period.

Previous meteoric falls have occurred as follows in England, and I give the last recorded case in Ireland:—

1795 December 13, Wold Cottage, 56 lbs.
1830 February 15, Launton.
1835 August 4, Aldsworth.
1876 April 20, Rowton, 7¾ lbs.
1881 March 14, Middlesbrough, 3½ lbs.
1902 September 13, Crumlin, Ireland, 9½ lbs.

W. F. DENNING.

NOTES.

A COURSE of twelve Swiney lectures on geology will begin on Saturday, November 14, in the lecture theatre of the Victoria and Albert Museum, South Kensington, by Dr. J. D. Falconer, who will take as his subject, "Land Forms and Landscapes." There will be no charge for admission to the course.

M. BOUTROUX, member of the Institute of France, and professor in the University of Paris, has accepted an invitation of the British Academy to deliver the first of the recently endowed annual philosophical lectures. His subject will be "Certitude et Verité," and the lecture will probably be delivered early in December next.

ANNOUNCEMENT is made that the Serbian Government is in immediate need of the services of qualified bacteriologists and physicians experienced in the treatment of epidemic diseases. Conditions of service and remuneration will be made by arrangement. Applicants should communicate with the Secretary of the Serbian Legation, 195 Queen's Gate, London, S.W.

A SHARP earthquake was felt over the whole of northern Italy at 10.20 a.m. (9.20 Greenwich mean time) on October 27. The scanty reports which have appeared in the newspapers show that it was sensible from Venice to Elba, and from Turin to Ancona—that is, over an area of not less than 70,000 square miles. The epicentre was apparently near Lucca, or between that city and Bologna.

COL. W. B. BRYAN, who, as chief engineer of the Metropolitan Water Board, had much to do with the improvement of the London water supply, died suddenly on October 27. Col. Bryan was to have delivered the Thomas Hawksley lecture on "Pumping and other Machinery for Waterworks and Drainage," before the Institution of Mechanical Engineers on Friday last, but the lecture has now been cancelled.

DR. F. B. POWER will retire from the directorship of the Wellcome Chemical Research Laboratories on December 1, in order to return to the United States of America. His period of service dates from the foundation of these laboratories by Mr. H. S. Wellcome in the spring of 1896. Dr. Power will be succeeded by Dr. F. L. Pyman. The character and policy of the Wellcome Chemical Research Laboratories will continue as in the past.

A REUTER message from Stockholm reports that the Swedish scientific institutions which have to award the Nobel prizes in December have decided, in view of the European situation, to postpone the distribution of the prizes for 1914 for literature, medicine, chemistry and physics until next year. It is now proposed to hold the formal presentation of the prizes every year in the month of June instead of on December 10, the anniversary of M. Nobel's death, when the awards will merely be announced.

A GENERAL discussion on the hardening of metals has been arranged by the Faraday Society, to be held on Monday, November 23, at the Chemical Society, Burlington House, London, W. The president, Sir

Robert Hadfield, will preside over the discussion, and among those who will take part therein are Prof. Ernest Cohen, of Utrecht, Dr. G. T. Beilby, Prof. J. O. Arnold, Prof. H. C. H. Carpenter, Dr. C. H. Desch, Prof. C. A. Edwards, Mr. H. L. Heathcote, Mr. J. C. W. Humfrey, Dr. T. M. Lowry, Mr. Andrew McCance, Dr. W. Rosenhain, and others.

THE Dorset Field Club will award in May next the "Cecil" medal and prize of 10*l.* for the best paper on radium: its present position, supply, and cost; with any recent discoveries on its curative effects. The competition is open to any person between the ages of seventeen and thirty-five on May 12, 1914, who either was born in Dorset or had on the date mentioned lived in the county for the preceding twelve months. Further particulars may be obtained from Mr. H. Pouncy, the *Chronicle* Office, Dorchester.

BY the will of Mr. W. Erasmus Darwin, eldest son of Charles Darwin, the Royal Society of London is bequeathed the sum of 1650*l.*; his nephew, Mr. C. Galton Darwin, receives the portraits of Charles Darwin by Lawrence and Ouless, as well as Darwin's medals, Royal Society's candlesticks, snuff-box, christening mug, autobiography, notebook on children, two early sketches of "The Origin of Species," two vols. of "Hooker's Correspondence," the family Bible, the old Dutch brass-bound box containing the family papers, large silver soup tureen, the counterpane worked with the coat-of-arms, the letters written home from the *Beagle*, and pictures and miniatures. The desire is expressed that these relics should always be kept in the family.

A RESEARCH prize of the value of 200*l.* has been placed by Sir Robert A. Hadfield, past president, at the disposal of the Iron and Steel Institute, to be awarded by the council for original research work on the different combinations of carbon in iron, steel, and alloys of iron with other elements. It is proposed that the prize shall be awarded at the annual meeting of the institute in May, 1916, for the best report presented before February 1, 1916. Sir Robert Hadfield is prepared to offer a second prize for the report next in merit to that which gains the first prize provided it is adjudged to be really meritorious. It is suggested that the work should be in continuation of, or based upon, the work of previous investigators. The object of the prize is to stimulate the study of carbides in iron and iron alloys generally, also with a view of discovering the best method of determining the forms and combinations in which carbon occurs in iron and steel. It is desirable to define the composition of these combinations more accurately and to ascertain whether other carbides exist which have hitherto not been identified. The study of the molecular constitution of the carbides will also fall within the range of the investigation. It is hoped that the results obtained will throw much light on the cause of hardness of steel, also on the nature and form of carbon combinations with iron and its alloys. Intending competitors should communicate, in the first place, with Mr. G. C. Lloyd, secretary of the Iron and Steel Institute, 28 Victoria Street, London, S.W.

Science of October 16 contains a memorial notice of the late Dr. Theodore Nicholas Gill, who died in Washington on September 25, in his seventy-eighth year. Although originally a law-student, Gill at an early age directed his attention to zoology, and in the winter of 1857–58, an expedition to the West Indies for the purpose of collecting shells and other natural history objects afforded him an opportunity of turning his inclinations to practical account. This was succeeded by a visit to Newfoundland in 1859, and in the following year he signalised his special interest in ichthyology by the preparation of a report on the fishes of the northern boundary for the U.S. State Department. Of wider interest was his catalogue of the fishes of the eastern coast of North America from Greenland to Georgia, published in 1861, of which a revised issue appeared in 1873. This and other works laid the foundations of his revised classification of fishes, which has been taken up and elaborated by Dr. D. S. Jordan and other American ichthyologists, and, according to the notice in *Science*, has now been accepted by European students of ichthyology. It must not, however, be imagined that Gill's work was restricted to fishes; on the contrary, it was unusually wide, embracing such diverse subjects as West Indian molluscs, the classification of mammals, and zoogeography. In 1861 Gill was accorded the chair of zoology at the Columbian (George Washington) University, Washington, a position he held until 1910, when he became emeritus professor.

SIR ERNEST SHACKLETON left Buenos Ayres for South Georgia on October 27 to carry on his trans-Antarctic enterprise. In a message to the *Daily Chronicle* of October 29 he announced some changes in the plans of the expedition. Instead of the *Endurance* returning to South Georgia and Buenos Ayres, after landing the members of the expedition, as was originally intended, she will winter in the Antarctic. Sir Ernest stated that on arrival at South Georgia all the dogs will be landed on one of the small islands of the group and left ashore. The geologists of the staff will also remain at South Georgia. The *Endurance* will then proceed south to examine the pack-ice and see whether it is loose enough to go into without unnecessary delay. After an examination of the pack the *Endurance* will return to South Georgia to pick up the members of the expedition and the dogs. The *Endurance* will be coaled to her fullest capacity, and, proceeding south again, will push right into the pack, keeping as much eastward as possible, in the hope of meeting more open water than is probably to be found further westward. Sir Ernest hopes to winter the vessel in 77·30° S. latitude, and if this point is gained at a sufficiently early date the transcontinental journey may be started this season. Should the ice conditions be too unfavourable, the journey will not be begun until October of 1915. The Argentine Government has provided the expedition with a wireless receiver, with which it will be possible to receive communications and time signals while the expedition is in the Antarctic.

IN the September number of *Folk-Lore* Miss C. S. Burne continues her valuable studies of the geographical distribution of British folk-customs. In this paper she deals with the customs known as souling, clementing, and catterning, practised in parts of the western midlands in November. They exhibit an example of successive layers of imported custom superimposed on a foundation of indigenous custom. First come the ancient, almost prehistoric, autumnal celebrations of the Old and New Year, probably always combined with a Feast of the Dead. Then Christianity transforms the pagan feast into the festival of Hallowmass. Next we meet with that combination of newly introduced subsidiary cults with newly organised and specialised crafts, which marks the progress of civilisation in the Middle Ages. Thus St. Clement and St. Catherine come into local prominence. Finally comes the period of decay, when the theological changes of the sixteenth century shatter the religious side of the kindly old customs, while simultaneously the centralising despotism of succeeding centuries and a civilisation growing more and more complicated deprive these rites, once so important, of any real significance, and they dwindle away or are kept up only by the most conservative part of the population, the children, wherever their elders allow them to benefit by them.

In *Ancient Egypt* (part iv.) Prof. Flinders Petrie concludes his instructive review of the analogies between the culture and beliefs of ancient Egypt and those of certain African tribes. Such analogies are indicated by royal functions, beliefs, and material products. Among the royal functions attention is directed to the widely spread African customs in connection with the priesthood of the chief, his removal before he attains old age, and the concealment of the fact of his death; in sister marriage; in the importance assigned to the royal placenta, the leopard skin, and the ox tail; and in the use of the saw-fish as an emblem. Among beliefs we find similar analogies in the conception of the mundane spirit world; animism; the ancestral spirit; the roads for the dead; the ideas about twins, animal or human; the ram-headed god; the bull god; totemism and animal clans; the sanctity of the sycamore and the fig-tree; the sacrifice of red cattle; and divination by objects thrown. Egyptian culture, again, is connected with that of other parts of the continent by its pottery, mud toys, wooden head-rests, the wooden hoe, double process spinning, the use of the flat ground-loom, mosquito-nets, harpoons, drag and hand nets, basket traps, ring snares, and the ornamentation of the head by means of a cone. Individually these analogies may be of slight importance, but their cumulative effect is considerable. These various transfers of culture seem to have taken place in at least three periods: under the twenty-fifth dynasty at Napata, in the sixth century B.C., and after the introduction of Christianity.

Part 3 of vol. vii. of the Journal of the College of Agriculture, Tohoku Imperial University, is devoted to a synopsis of the Japanese chrysopid Neuroptera, with descriptions of several new species, by Mr. H. Okamoto. In connection with this may be mentioned a catalogue of books on entomology, chiefly from the library of the late Mr. Herbert Druce, issued by Mr. F. Edwards, High Street, Marylebone, W.

Lifelike photographs of grey-lag geese and of a specimen of the greater courlan (*Aramus giganteus*) recently received at the London Zoological Gardens form some of the most striking features in the October issue of *Wild Life*. The reader should, however, not have been left in the dark as to the native home of the courlan, and the attention of the editor may be directed to the need of greater care in proof-reading, as exemplified by the repetition on p. 32 of the statement that the sand-lizard is a slow mover, and of the substitution of "specimens" for "species" in the middle of p. 34.

Investigations carried on by Mr. W. E. Collinge with the view of ascertaining the nature and quantity of the food of nestling sparrows have shown that in fruit-growing districts one hundred of these birds will consume nearly 2000 insects, and in suburban neighbourhoods about one-third of that amount. That sparrows are far too numerous is fully admitted; but it is suggested that if their numbers were considerably reduced they might be included in the list of benefactors. This and other information on the subject will be found in the October issue of vol. xxi. of the Journal of the Board of Agriculture.

An excellent piece of systematic work is formed by Mr. A. H. Howell's revision of the so-called American harvest-mice, constituting the genus Reithrodontomys, published by the Smithsonian Institution as No. 36 of the *North American Fauna*. These mice, of which no fewer than fifty-five distinguishable forms are recognised, are chiefly a North American type, although the group also ranges through Central America to the northern States of South America. In the main essentially field-mice, they are in most districts only moderately numerous, although in a few they make their appearance in large numbers. As a rule, they do little harm, feeding for the most part on plants of no value to man.

In *Symons's Meteorological Magazine* for July last Mr. L. C. W. Bonacina asked readers who had been in India whether lightning casualties, notwithstanding the severity of tropical storms, are not much rarer there than with us. He pointed out that many persons agree that thunderstorms in England are much more dangerous than in India. In the issue for October a correspondent ("G. G.") states that in the course of his travels in various parts of India, during a period of several years, he had only known or heard of one case of death by lightning, although a few high buildings, notably near Delhi, and tall trees in mountain districts, had been struck. He therefore answers Mr. Bonacina's question in the affirmative, the reason given being that thunderstorms occur higher up in the air. He states that he has never seen lightning in India so near the earth as he has in England.

During this summer experiments have been made with Langley's original "aerodrome" of 1903, and have proved that this scientifically designed pioneer machine is capable of flight with precisely its original propulsive plant, wings, and rudders, and with 40 per cent. extra aggregate weight due to floats and their attachments. An account of these experiments is given in the *Scientific American* for October 10.

MESSRS. G. MICHAUD and F. Tristan, writing in the *Scientific American*, describe photographs and observations on the absorbing power of different flowers for invisible light. They find that the majority of flowers come out dark when photographed in ultra-violet light, but that a certain number of yellow flowers reflect the ultra-violet rays in a marked degree. In the case of the Compositæ this property is only exhibited by the exterior corollas. On the other hand, most flowers of any colour appear to reflect infra-red light to an equal degree.

IN the *South African Journal of Science* for September (vol. x., 14) Mr. Pedro Luis de Bellegarde da Silva advocates the use of wireless telegraphy in connection with the surveying operations now in progress in the province of Mozambique. At present these operations involve considerable delay owing to the peculiar nature of the country, and it is suggested that a distributing station at some place, such as Lourenço Marques together with small portable wireless outfits would enable the survey to determine the longitudes of many points in the province with greater expedition and accuracy than is possible with the present use of chronometers.

"THE Propagation of Disturbances in Dispersive Media" forms the title of No. 17 of the "Cambridge Tracts in Mathematics and Mathematical Physics," by T. H. Havelock (Cambridge University Press, 1914; pp. viii+87; price 3*s*. 6*d*. net). In it the author applies Fourier analysis to investigate the changes of form of a disturbance propagated in a medium in which the wave velocity is a given function of the wave-length. The theory of groups of waves of the most general type is thus discussed, and applications to optical problems are considered.

PART 213 of the Proceedings of the American Philosophical Society contains a paper by Prof. A. E. Kennelly and Mr. H. S. Sanborn, read before the society on April 24, which gives the results of a research carried out at Harvard University in 1911 on the effect of air pressure on the heat carried away from a hot wire by an air current blowing across it. In the original experiments of Prof. Kennelly and his pupils in 1909 it was shown that the watts which had to be spent in the wire to keep its temperature constant (400° or 500° C.) when air blew across it at a speed v between 200 and 2000 cm. per sec. varied as $\sqrt{v}$, but at lower speeds as $\sqrt{v+30}$. As Boussinesq in 1901 showed that the heat loss should also vary as the square root of the density of the fluid used, the present observations were made in a tank at various pressures, and it was found that for pressures above atmospheric the law held, but at lower pressures the power of the density was more nearly 0·4. They conclude that the constant of their heated wire wind velocity measurer or anemometer requires to be corrected for both temperature and pressure of the air. The effect of moisture in the air appears, however, to be small.

FOR many years there has been periodical agitation for the construction throughout the country of large granaries in order that there might be no possibility of a famine in the event of war. So far as the war has gone, the pressure of the Navy has shown that those who contended in favour of absolute ensurance of the command of the sea, in preference to such tentative measures, were right. Nevertheless, the immense granaries, which are increasing in number at our great shipping ports, are welcome on account of the facilities they afford for the discharge and distribution of grain, and for ensuring an adequate supply at the outset of war. The latest of these granaries, built by the Clyde Navigation Trustees at Glasgow, is described in *Engineering* for October 30. This granary has a total length of 312 ft., a width inside of 72 ft., and a total storage capacity for 31,000 tons of grain. While not so large as corresponding arrangements in Canada and the United States, the structural details of the Glasgow granary and the design of its machinery for discharging grain from ships and distributing it into and out of silos, are thoroughly representative of the best practice of the day, and of great and prolonged experience.

A LIST of the titles of English, American, French, and German medical and other scientific periodicals, together with prices of subscription, including postage to any part of the world, has been issued by Mr. H. K. Lewis, 136 Gower Street, London. Though only the leading publications are included, the list contains nearly 300 names. The periodicals published in Germany cannot be supplied during the war. The list will prove of particular service to librarians and of interest to medical men generally.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—M. Bigourdan communicates to the *Comptes rendus* for October 27 (vol. clix., No. 17) the substance of a telegram received from M. Comàs Solà, director of the Fabra Observatory, Barcelona, recording the discovery of a comet in a region of the sky recently occupied by Encke's comet. Its position on October 25 at 16h. mean Barcelona time is given approximately as R.A. 11h. 27m., and declination $+50^\circ\ 36'$, and the movement is in a south-south-east direction at the rate of 5° a day. The comet is stated to be visible with a pair of opera-glasses.

THE COMET RECENTLY OBSERVED AT THE CAPE.—In this column on October 8 (p. 151) we recorded the appearance of a bright comet observed at the Royal Observatory, Cape Town, and published an ephemeris up to October 13, computed by Mr. Wood, of Johannesburg. The comet was stated to be fading, and at the same time to be rapidly decreasing its southern declination. This object has now been recorded from Barcelona, where it was photographed on October 17 last (*Comptes rendus*, vol. clix., No. 16, October 19). The note by M. Comàs Solà, presented by M. Bigourdan, to the French Academy, records its position as being R.A. 21h. 53m. 12s., declination -3° 14 at 8h. 9m., Barcelona mean time, the place being determined from a photograph which showed the comet with a tail. Its direction of movement is given as north-north-west.

A LITTLE-KNOWN PIONEER OF SPECTRUM ANALYSIS.—While we owe the birth of spectrum analysis to Sir Isaac Newton (1642–1727), the first use of the slit to Wollaston (1802), and the first accurate mapping of the solar spectrum to Fraunhofer (1814), the name of the young pioneer, Thomas Melville, who followed closely after Newton is nearly forgotten. Although Melville died in 1753, at the age of twenty-seven, he was the first to employ the prism in laboratory research, for he undertook the examination of various flames, introducing sal ammoniac, potash, alum, etc., into burning spirits. He was undoubtedly the first to observe the yellow soda flame and notice its definite frequence in flames and its position as regards other colours. His name is briefly mentioned in Sir Henry Roscoe's "Spectrum Analysis," and Miss Clerke's "History of Astronomy," gives him full credit for his work. It was in reading the latter book that the attention of Mr. John A. Brashear was directed to the reference to Melville. Through Mr. Carnegie and Dr. Hew Morrison, the latter being principal librarian of Edinburgh, Mr. Brashear was enabled to obtain copies of Melville's essays read before the Medical Society of Edinburgh on January 3 and February 7, 1752, on observations on light and colours, in which appears the remarkable observation of the peculiar sodium light. These papers are now reprinted in the current number of the Journal of the Royal Astronomical Society of Canada (vol. viii., No. 4, July-August), and a very good service has been done by making them available to everybody.

DISPLACEMENT OF SPECTRUM LINES AT THE SUN'S LIMB.—Messrs. J. Evershed and T. Royds describe in Kodaikanal Observatory Bulletin, No. 39, some further researches they have been carrying on with regard to displacements of the spectrum lines at the sun's limb. Two explanations have been suggested to account for these shifts, one view being that they are due to pressure and the other due to motion in the line of sight. In this paper the authors state that the pressure theory presents a much more rational explanation of the phenomenon than the motion theory, but hold that there are difficulties in accepting the former, which have not been lessened, but largely increased by further research. The authors consider that the relative shifts of different lines at the limb have no particular meaning when determined by reference to lines at the centre of the disc, for these latter have shifts peculiar to themselves; the measures they have made show that the absolute shifts of the lines at the limb referred to a terrestrial standard show no relation to pressure shifts, and, further, the absolute shifts do not increase with the wave-length. In the investigation now published they determine the limb shifts by combining measures of limb minus centre shifts, with the centre minus arc shifts, the algebraical sum representing the absolute or limb minus arc shifts. They deal with the limb shifts in relation to the intensity of the lines, the relation between limb shifts and pressure shifts, limb shifts in relation to wave-length, and the shifts of the cyanogen bands. The conclusions they arrive at are that both the so-called cyanogen bands and the iron lines show shifts which they attribute to a movement of recession from the earth. While the view that the solar gases are actually repelled by the earth receives some support from other lines of evidence, they consider an alternative hypothesis, namely, that the sun's gravitational field affects the wave-length of the light emitted in accordance with Einstein's theory of relativity.

CLIMATOLOGY.

A PAPER by Dr. J. H. Garrett (Medical Officer of Health) on "The climate and topography of Cheltenham and its near neighbourhood" is published in the Proceedings of the Cotteswold Naturalists' Field Club for 1913 (vol. xviii., part ii.). The tables for thirty-five years (1878–1912) are derived from the records contained in annual health reports, or from the summarised values issued by the Meteorological Office. The figures show, as the author points out, that as regards the mean monthly maximum and minimum temperatures, the alternations from one season to another are very gradual. For the years 1892–1912 these were, respectively:—January, 43·6°, 33·6°; July, 71·6°, 53·4°; absolute maximum, 93° in September, 1911, minimum 6·5° in February, 1895. The annual rainfall shows considerable variation: 19·5 in. in 1892, 37·9 in. in 1882, normal for thirty-five years, 26·8 in. The prevalent wind directions are S.–W., those from N.–E. are comparatively few, while calms are very frequent. The average yearly sunshine (1903–12) was 1553 hours. Dr. Garrett remarks that quite a different climate is experienced on the Cotteswold Hills, within four miles of the centre of the town.

An elaborate discussion by Dr. V. Conrad of the climate of Carinthia, being part vi. of the valuable climatology of Austria, has been published by the Central Meteorological Institute of Vienna. This mountainous province covers an area of 10,327 km^2, of which 53·7 per cent. is above the level of 1000 metres. Like other Alpine countries it partakes of the sea climate of western Europe and of the land climate of eastern Europe, and is subject to abrupt contrasts within short distances. Tröpolach, for instance, in the Gail Valley, with an eastern aspect, has a mean January temperature of 18·7° F. and a winter temperature of 22·3°, while Pontafel, 7½ miles S.S.W., with a south exposure, has a January temperature of 28·6° and a winter temperature of 30·6°. The mean absolute yearly range of temperature in some of the valleys amounts to above 50° C. (90° F.); the absolute extremes recorded were below −22° F. and above 95° F. The yearly distribution of rainfall is well shown by a tinted map, referring to the period 1876–1900. With few exceptions there is a tendency towards increase of rainfall from north to south. The driest parts are the Noric Alps and neighbouring districts, with 31–35 inches of rain; the wettest parts are in the south-west, with 58–78 inches. The province possesses several long series of observations, *e.g.*, for Klagenfurt since 1813, but there is only one sunshine recorder, which is at the latter station.

Dr. Filippo Eredia has recently contributed to the *Rendiconti* of the Accademia dei Lincei (vol. xxiii.) two interesting memoirs on the distribution of cloud in Italy. The papers show the seasonal and annual distribution for 132 cities, and the orographic influence on the monthly mean values at a number of stations in the valley of the Po. In the latter region, on the Adriatic, central and lower Tyrrhenian, and Ionian slopes, winter is the season of most cloud. On the upper Tyrrhenian slope and on those near the Alps, spring is the cloudiest season. At Alpine regions and those under the direct influence of mountain systems there is generally least cloud in winter and in summer at other stations. The mean annual distribution and amplitude are shown by diagrams.

Another paper by Dr. Eredia, on the climate of Southern Italian Somaliland, is published by the Colonial Ministry of Rome as No. 14 of *Rapporti e Monografie coloniali*. The observations include *inter alia* those made by the Italian expeditions and at stations afterwards established, and are carefully discussed under six separate elements. The climatological conditions are dominated by the N.E. monsoon (December–March) and the S.W. monsoon (June–September). The author points out that the temperature is very regular, there being only a difference of a few degrees between the means of the hottest and coldest months. The absolute maximum and minimum quoted during 1910–12 at six selected stations are 98·6° (in April) and 59° (in August), both recorded at Brava. The rainfall reaches its maximum values in April and November; the first rainy period is followed by falls of decreasing intensity and frequency in the coastal districts, and the second period by very scanty falls in the interior and extreme dryness on the coast. The largest yearly mean quoted is 30·1 in. (on fifty-two days) at Balad, and the smallest, 10·6 in. (on thirty-three days) at Giumbo. Generally speaking, rain falls in eight months on the coast and ten months in the inland districts.

The Bulletin of the Italian Royal Geographical Society for August contains a useful contribution to the climatology of Ethiopia by Dr. Eredia and Dr. De Castro. The results are chiefly based on observations made partly at Addis-Abeba and partly at Addis-Alem, from November, 1901, to June, 1911, excepting between July, 1904, and April, 1905, with instruments supplied by the Italian Meteorological Office. Monthly results for each year are given for temperature and rainfall, and in a less complete way for humidity and wind-direction. The mean annual temperature is 62·1°; highest mean monthly maximum, 80·1 (May); lowest mean minimum, 42·8° (December); absolute maximum, 100·4° (September); absolute minimum, 32·0° (December). The annual rainfall is 47·7 in., on 148 days. The authors' division and description of the seasons give a good general idea of the climate: winter (October–December), low temperature and scarcity of rain; spring (January and February), moderate temperature and relatively small rainfall; summer (March–June), high temperature and relatively large rainfall; autumn (July–September), moderate temperature and abundance of rain. The division of the year into seasons by the natives is essentially based on the occurrence of rainfall periods.

An article by Prof. Karl Dove, on the climate of German South-west Africa, was contributed to *Himmel und Erde* of December, 19, 1913. The protectorate extends from 17° to 29° S. latitude, but its position on the west side of the continent greatly modifies its climatological features, as compared with those on the eastern shore. Near the coast the cold water of the Benguella drift-current reduces the temperature considerably; but the inland parts owe their relatively low temperature to their great elevation above the sea. The annual range is very regular, and the approach of summer or winter has little interest for the inhabitants compared with the date, duration, and amount of rainfall. The heavier falls mostly occur between January and March; irrespective of small variations, Prof. Dove states that, with the exception of the extreme south, six- to seven-tenths of the year's rainfall may be referred to those three months. In large tracts of the western zone the annual fall does not exceed eight inches, and in some years little or no rain falls, not only in the coastal districts, but also in the interior of the country.

A very interesting and useful work on the climate, typhoons, and earthquakes of Formosa, with tables and diagrams, has recently been issued by the Government-General of that island. The meteorological service was organised in 1906 under an Imperial Japanese ordinance; observations are made at ordinary stations, lighthouses and rainfall stations, and the work is carried on almost entirely at Government expense. The central observatory at Taihoku receives and discusses all observations and also receives a number of telegrams and issues weather forecasts and storm-warnings for the whole island. The climate is subtropical, and may be divided into two seasons; the seven months April to October may be regarded as summer, and the five months November to March as winter. Throughout the island the mean monthly temperature rises to 68° F. in April; from June to September it ranges between 79° and 82°. The highest readings reach about 95°, and in rare cases exceed 98°. In winter the variations between the north and south of the island become more apparent; in February, the coolest month, the mean is about 58° in the north, and 68° in the south. The lowest readings in the north do not usually fall below 41°, and in the south not below 49·6°. In winter the N.E. monsoon brings rain to the northern parts, and in summer the S.W. monsoon and thunderstorms bring abundant rain to the south; the island, therefore, possesses two rainy seasons, each differing in time and place. Formosa lies in the highway of typhoons, and is often visited by those destructive storms; during seventeen years (1897–1913) thirty remarkable storms occurred during the months June to October. Earthquakes are also frequent; all the ordinary observing stations are supplied with seismographs, and shocks are recorded somewhere in the island about every day and a half. The most violent earthquakes are generally in the south-west, and occasionally cause disastrous damage.

ORNITHOLOGICAL NOTES.

THE eighth volume, comprising 533 pages of text, of the *Boletin do Museu Goeldi* (*Museu Paraense*) is devoted to a catalogue of the birds of Amazonia—Catalogo das Aves Amazonicas—by Dr. E. Snethlage. The author, who joined the staff of the museum at Para in 1905, commenced work on this catalogue very soon after his arrival, and devoted to it a large portion of his time during the following half-dozen years. Fortunately, the collection of bird-skins in the museum—some 10,000 in number—is sufficiently comprehensive to have enabled him to accomplish his task on a thoroughly scientific and first-hand basis. The result is a work which forms a worthy companion to Dr. Ridgway's "Birds of North and Middle America," albeit in an absolutely and relatively smaller compass. The author is, indeed, to be congratulated on the conciseness of the generic and specific diagnosis and the clearness of the "keys."

In connection with the above may be noticed the concluding portion of Mr. R. Dabbene's distributional list of Argentine birds, which appears in No. 6 of the first volume of the *Boletin de la Sociedad Physis*, Buenos Aires. The author recognises a total of 324 species. In Dr. Snethlage's catalogue the species are not numbered.

In an editorial article in the August issue of *Wild Life* it is stated that the Paris Committee of Economic Ornithology has been discussing a scheme for breeding white egrets in the marshes of Corsica, and also for rearing these and other birds with valuable plumage in Tunis. In the latter country the idea is that the Government should offer stock-birds on easy terms to the colonists, such birds to remain Government property, but the resulting offspring to belong to the breeders. The same issue contains two beautifully illustrated articles on Spanish heronries, where white egrets, night-herons, and other allied species breed in large colonies.

The July number of *The Emu* contains coloured illustrations of two species of parrots from Northern Queensland, severally representing genera unknown to occur on the Australian mainland until last year. The first is a local race of Geoffroy's parrot (*Geoffroyus personatus* or *G. geoffroyi*) of Timor, and the second of the red-sided parrot (*Eclectus pectoralis*) of New Guinea. That such common and brilliantly coloured birds should have so long escaped detection in a country like Northern Queensland is very remarkable.

In an article on the ecological relations of bird-distribution, published in the July issue of *British Birds*, Mr. S. E. Brock remarks that while the composition of a country's avifauna is, in one sense, directly related to the present and former configuration of land-masses, the form of its dispersal within the area is immediately attributable to the environmental control. In other words, "the efficient causes of separation between bird-groups in this country are less geographical than ecological; the specific environment is the true 'faunal area.' The group of species attached to a specific habitat compose an association the units of which are primarily inter-related through the connecting link of a common environment."

As the result of a recent comprehensive inquiry, by the issue of circulars, Mr. H. G. Alexander is enabled to give, in the September issue of *British Birds*, a full account of the present status of the landrail in the British Isles. Throughout the south and east of England, at least from Devonshire to Lincolnshire and inclusive of the south-east Midlands, this once abundant species no longer breeds regularly, although a few pairs nest annually in most counties. In South Wales, the West of England, the Midlands, and so far north as the Pennine Range and the Yorkshire moors, a general decrease in numbers, apparently of more recent date than that in the east and south, is now in progress; but in the Pennines and the districts west of the same no decided diminution is noticeable, landrails being still abundant throughout this area, except on the moors. Everywhere the birds are recorded as mainly frequenting grass or clover, and seldom cereals. Whether this was always the case, or whether they formerly nested in corn, has an important bearing on several of the theories which have been advanced to explain the diminution in the numbers of the species.

In the same issue is recorded the occurrence on May 6, 1914, of a pair of Rüppell's warbler (*Sylvia rueppelli*) at Baldslow, Hastings. This is the first British record of this rare east European species.

To the Transactions of the New Zealand Institute for 1913 (vol. xlvi) Prof. W. B. Benham contributes an article on the nomenclature of New Zealand birds, based on the *Reference List* of Mathews and Iredale.

Another article in the same volume, by Mr. H. Hill, gives the fullest account hitherto published of the history of the early discoveries of moa-remains in New Zealand, together with a discussion as to their geological age, and the probable date of extermination of these giant birds. Contrary to the now generally accepted view that moas were killed off by the Maoris within the last few centuries, the author affirms that these birds lived during the late Pleistocene—the epoch of intense volcanic action in New Zealand—and that they all perished suddenly as the result of such seismic disturbances and the emission of poisonous vapours long previous to the advent of the Maoris, or any other race, in the islands. Basing his views solely on the result of observations on the east coast, Mr. Hill proceeds to observe that none of the numerous moa-remains found in caverns show any evidence of having been touched by men or dogs; and he considers that when the great seismic cataclysm occurred all the birds rushed to the upland caves for refuge—where they were in many cases imprisoned by the fall of pumice in front of the entrance—while others perished in the open, choked by clouds of ashes or by noisome vapours; the remains of these latter being subsequently carried down to the lowlands by floods. No reference, it may be added, is made to the comparatively fresh condition of moa-remains in many districts, or to their alleged association with Maori camping-places and camp-fires.

In an article on birds observed last spring during a yachting cruise amid the Scottish islands, published in the August number of the *Scottish Naturalist*, the Duchess of Bedford directs attention to the vast numbers of fulmars snared at that season by the natives of St. Kilda, who bring them in by boat-loads. Such a practice, remarks her Grace, seems short-sighted on the part of people who depend largely upon these birds for a living; but, nevertheless, the fulmars still maintain their numbers. On the "Stack," which was also visited, the number of gannets has been estimated by one observer at 8000, and by a second at 50,000; a revised estimate is between 5000 and 6000.

R. L.

ENGINEERING AT THE BRITISH ASSOCIATION.

THE proceedings in Section G opened at Melbourne with a paper by Prof. Petavel on aviation research. The author described the results of recent experiments on the air resistance of various shaped bodies at different speeds, and also on the lifting power of planes of various shapes. This was followed by a paper on railways and motive power by Prof. Dalby, who showed a number of curves relating to the development and cost of working of British railways, and discussed briefly the relative advantages of steam and electric traction. Mr. Hedley Thomson followed with a paper on a transmission system suitable for heavy internal-combustion locomotives, in which he maintained that the difficulties of the internal-combustion locomotive were mainly due to the want of a suitable variable-speed control mechanism, and that these difficulties were overcome by the Thomas transmission gear, which he described. Curves were shown illustrating the high efficiency and other advantages to be obtained in this way. The internal-combustion locomotive is of special importance in Australia because of fuel and water difficulties. A paper was then read on the Canberra plan by Mr. W. B. Griffin, who was awarded the premium offered by the Commonwealth for the best town-planning scheme for the new Federal capital. The paper dealt with the principles underlying the design of such a town and their applications to the site at Canberra. The Government exhibited a number of elevations showing what Canberra will look like if and when the present scheme is carried through. The concluding paper on the first day was by Mr. Kirkpatrick, on the development of the Port of London.

On the second day Dr. Rosenhain read a paper on the behaviour of metals under strain, and showed a large number of photomicrographic slides illustrating the crystalline structure of metals under various conditions of strain and temperature. He showed that the various phenomena could be explained on Beilby's hypothesis of the amorphous phase in metals. Prof. Dalby then described an attachment for testing machines by means of which the stress-strain diagram is photographically recorded as the stress is applied. He also showed some photomicrographic slides of the structure of metals. A well-illustrated paper by Mr. Humphrey on the Humphrey pump was next read. The discussion showed that Australian engineers were fully alive to the importance of this pump for irrigation, but several speakers regretted the apparent departure from its initial simplicity in order to meet special conditions. Prof. Coker read a paper on the stress distribution in short compression members. By means of a transparent specimen and polarised light, the peculiar stress distribution due to the compression plates being of different material from the specimen was illustrated. It was shown that approximately pure compression stress can be obtained if both are of the same material. Sir Oliver Lodge read a paper on the artificial electrification of the atmosphere, in which he dealt especially with the production of rain by the direct electrification of the clouds. The proposal was adversely criticised by Dr. Simpson, of the Indian Meteorological Department, and by Mr. Hunt, the Commonwealth Meteorologist. It was pointed out that clouds are very poor conductors, hence the difficulty of giving them an electric charge, and, moreover, that the clouds are often very highly charged, as shown by lightning discharges, and yet without causing rain.

The third day was devoted to a joint discussion with the Agricultural Section on irrigation, opened by Prof. Luiggi, of Rome, with a very interesting paper on irrigation works in Italy. The author showed that irrigation and ceaseless toil had transformed large areas of arid land into smiling gardens. He went very fully into the financial aspect of the question, showing that irrigation schemes require Government support, and are not suitable for private enterprise. He described the engineering features of several of the large schemes now being developed in Italy. A paper on somewhat similar lines, entitled "Irrigation in Victoria," was read by Mr. J. H. Dethridge. Papers were read by Mr. Ferrar on the fertility of lower Egypt, and some factors controlling the growth of cotton.

The Sydney meeting opened with the presidential address on stress distribution in materials. The president, Prof. E. G. Coker, discussed the various experimental methods, dealing especially with two, viz., the measurement of local temperature rise due to strain, and the application of polarised light to transparent test-pieces. Mr. A. B. Wade read a paper on irrigation in New South Wales, in which, after discussing the rainfall and physiography of the State, he described the irrigation schemes now in hand, especially that in the Murrumbidgee area. He also described the construction of the great Burrinjuck dam. Prof. Luiggi showed a large number of lantern slides illustrating the works carried out under his direction in Tripoli since the Italian occupation; these include lighthouses, harbours, waterworks, railways, etc. He emphasised the fertility of a great part of the country, and pointed out that it was a great grain producer in the days of the Roman Empire, and that with irrigation and development it should once more become a prosperous agricultural country. Mr. T. W. Keele discussed the Nile flood records between A.D. 641 and A.D. 1451, in which he claims to have found a periodicity of seventy-six years and suggests a connection with Halley's comet. Prof. Dalby described the new engineering laboratories of the City and Guilds (Engineering) College, which are at present nearing completion.

On the second day Mr. Bradfield read a paper on the new electric metropolitan railway, for which Sydney is seeking Parliamentary sanction. The scheme includes a bridge of 1600 ft. span across the harbour, and the total estimated cost of the whole scheme is 17,000,000*l*. A paper was read by Mr. Adams on the Australian ports in relation to modern shipping, in which the author discusses the great demands made on the port authorities by the increased length and draught of modern ships and the consequent outlay which neutralises to some extent the saving effected by the increased capacity of the ships. The new wharf arrangements at Sydney were described.

Dr. Rosenhain followed with a paper on the distribution of phosphorus in steel, in which, after describing a new reagent (ferric chloride with small quantities of copper and tin chlorides) for tinting the surface and thus revealing the want of uniformity in the distribution of the phosphorus, he showed a number of photomicrographic slides. Prof. Hudson Beare described tests which he had made on two petrol fire-engines, and also on the resistance offered to the flow of water by canvas fire hose.

On the last day of the meeting Prof. E. G. Coker read a paper on the temperature cycle in heat engines, describing a method of obtaining records of the temperature cycles in gas-engine cylinders by means of thermo-junctions operating an Einthoven galvanometer. Prof. Thornton followed with a paper on the lost pressure in gaseous explosions, in which he suggested that the difference between the calculated and measured maximum pressure may be due to the sudden effect of the forces of cohesion in converting translational into rotational energy at the moment of formation of the molecule. A second paper was read by Prof. Thornton on the limiting conditions for the safe use of electricity in coal mining, in which he discussed the danger of explosion from electric sparks under various conditions. Mr. Balsillie contributed a paper describing the system of radio-telegraphy with which his name is identified, and which has been adopted by the Australian Government, the chief features of which are that electrostatic coupling is employed between the oscillatory circuit and the aerial, and that a gap is employed with a very powerful air-blast, which, it is claimed, gives a unidirectional spark and consequent quenching after a semi-period. In a paper on the capacity of radio-telegraphic aerials, Prof. G. W. O. Howe described a method of calculating rapidly the capacity of any type of aerial.

Two reports were presented by research committees; that by the committee on stress distributions in engineering materials consists mainly of a review and bibliography of the experimental methods of investigating the subject, especially the application of polarised light to transparent test-pieces. A number of the committee are engaged on work which is not yet completed. A stock of 3 tons of standard steel has been obtained so that all members may work on the same material and thus enable their results to be correlated.

The report of the committee on gaseous explosions summarises previous reports and discusses the measurement of the temperature in gas-engine cylinders, especially the method employed by Profs. Callendar and Dalby at the City and Guilds (Engineering) College.

A joint discussion between Sections A and G on wireless telegraphy was held at Sydney. Sir Oliver Lodge, who opened the discussion, reviewed the various explanations put forward to account for the transmission of signals around the curvature of the earth, and the variations due to the alternation of light and darkness. Mr. Balsillie, the Commonwealth wireless expert, communicated some very striking observations; he had found that with a wave-length of 600 metres the ranges by day and night were 450 and 2000 miles respectively, and that by increasing the wave-length the day-range was increased while the night-range remained unchanged. Enormous variations in the day-range were produced by small changes in the wave-length, *e.g.* from 600 to 800 metres. The long range at night was obtained equally well over land or sea, which suggested that the waves travelled through the upper atmosphere and not in proximity to the earth. Prof. Howe showed curves indicating in some cases a marked maximum in the strength of signals at midnight, and not, as one might expect, a uniform strength during the whole period of darkness. Dr. Eccles related some remarkable effects noted in the neighbourhood of Pago-Pago, a very lofty pinnacle of highly insulating lava with a wireless station on the summit. A ship near the island received distant signals better when the island was in a position to intercept the waves, as if the lava pinnacle deflected the waves and concentrated them on the ship.

MALARIA AND THE TRANSMISSION OF DISEASES.[1]

WHEN I received the distinguished honour of being invited by the committee of this school to deliver the biennial Huxley Lecture—an honour depending not only on the merits of the school itself, but on the names of some of the greatest leaders of the profession who have actually delivered the lecture in the past—I conceived it to be my first duty to select a theme which might be worthy of the occasion. In that fine book, the "Historical Account of the Charing Cross Hospital and Medical School," by Dr. William Hunter, the eminent dean of the school, it is shown that the founder of the hospital and the school, Dr. Benjamin Golding, had already recognised so long ago as 1821 the importance of the study of tropical medicine; and it was therefore impossible that the subject of my lecture of to-day should not lie in this field. But the field is large; and I should be losing myself in the sand of too great diffusion were I even to attempt a cursory survey of it. It was told, however—and gathered from the lectures of my predecessors—that what my audience most desire to hear would be, not remarks upon others' findings, but rather a succinct history of personal experiences, displayed from the widest point of view. I say this to excuse my somewhat personal choice of theme. The history will be a survey of the past; and, though wider for that reason, may be the more lacking in interest to some of you who perhaps have already heard much of these combats of a day already bygone. It is the narrative of a very humble foot-soldier, but one, alas! who is no longer employed by his country at the front. My subject will be malaria and the transmission of diseases.

First allow me to add a little wreath to the monument which the past lecturers have erected to the memory of the great Huxley—and I should like to place it upon a vacant spot. We all know Huxley as the St. Paul of evolution, the bulldog of Darwin (as he described himself), and the interpreter of Darwin's profoundities to the world; and we also know him as the patient and passionate investigator and the patient and dispassionate thinker regarding phenomena. But, in my opinion, he was still more—though not a higher thing—a philosopher. Like thousands of others, I have been fed and refreshed with those wonderful essays, which, when, as his biographer tells us, his hand grew heavy for dissections, he gave to the world in his latter days. To my mind he had all of the very first qualities required for true philosophy. The clarity of his style, which he possessed in common with Hobbes, Locke, and Hume and the great French philosophers, was itself a guarantee of the genuineness and completeness of his thought—so different from the obscurity and pretension of style which many philosophers from the days of Herakleitus onwards have employed to cover their emptiness. Secondly, his mind was fiercely critical in its search for truth, and he accepted nothing as fact which he himself had not endeavoured to probe into to the depths. Thirdly, no one has ever doubted that his aim was, not to astonish or to defeat or to persuade, so much as to reach the actual truth of every matter which he dealt with; and this serves to distinguish him from many of those who work in a field which is particularly open to pretence and even to charlatanry. We all trust Huxley. He may have been wrong for want of facts, but not for want of sincerity and effort. It is the fashion of one generation to decry the labours of the preceding generation; but as time advances this error is put right, and Huxley will be seen from the distance to soar more and more above the eminent writers of his own time.

I can imagine nothing that would have delighted him more than the bearing of recent advances in science on the medicine of the tropics. Indeed, this latest victory of science, achieved after his time, may be considered as a culminating point in the practical application of science to the needs of suffering humanity. The victory has been won, not only by medicine, but by medicine and zoology fighting side by side—by those two great branches of science in which he himself was so proficient. Let me now describe the details of the campaign.

It is curious that though the transmission of disease is a matter of such vast import to every one of us, it has received so little investigation in the past. Even up to the middle of last century, our inquiries had led us little further than what I call the subscience of the subject—that is, we distinguished, classified, and named our various bodily inflictions. We also did more; for we had ascertained empirically the physiological and therapeutical effect of many drugs—quinine, opium, mercury, iodide of potassium, ipecacuanha, and others; and also that great genius Jenner had discovered a wonderful fact which is at the basis of the theory of immunity, prevention, and cure. But the causes of disease and their mode of transference still remained hidden. At that epoch, however, and afterwards, Pasteur, Koch, Lister, Behring, and others created the science of bacteriology. But still, though the information thus obtained was of prime importance to the pathologist, the physician, and the surgeon, we still remained much in the dark regarding one important issue, namely, the exact path of transmission of many diseases from man to man. Bacteria are easily saprophytic, and may have many paths of transmission, and, I fear, that we are still very much in doubt as to the most important of these numerous routes. We thought, and are often still inclined to think, that the germs of disease come to us from any place where they may be scattered—that they have not precise routes and points of entry. This leads us to a very vague prophylaxis. We undertake all kinds of disinfections in order to destroy the enemy, wherever he may possibly lurk; and the consequence is that we often fail to check infection as certainly as we wish. It has been the great result of the inquiries which I will now proceed to describe that they have, as the French say, precised our knowledge upon this point in connection with many diseases, and have indeed led to the discovery of another and most wonderful route of infection which until recently was undreamed of by the profession and the public.

The armies of science, like those of nations, commence with small beginnings and advance in parallel columns. If one column is checked by insuperable difficulties, the others endeavour to outflank the point of resistance; and a victory is often won by this means in science as in war. (Excuse my military similes, which appear to be appropriate at this hour.) That column of science which conquered the domain of bacteriology was brought to a standstill for some time as regards the exact transmission of disease until the parallel column attacking from quite a different direction circumvented the difficulty in this respect.

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[1] The Huxley Lecture. Delivered at Charing Cross Hospital on Monday, November 2, by Sir Ronald Ross, K.C.B., F.R.S.

The story commences with the studies of those obscure and often despised workers who toiled in the domains of parasitology. Some of the largest parasites were known in antiquity; but the ancients possessed quite a wrong notion of their origin, which they attributed to spontaneous generation—that is, they thought the parasites originate *de novo* in the host. In the seventeenth century, however, Radi proved that this hypothesis does not hold for certain insects; and later Pallas argued that parasites originate *ab ovo,* like other animals—that is, that their eggs escape from one host and enter another host, thus leading directly to the presence of parasites in the latter. This history possibly still holds for certain parasites; but in 1790 Abildgaard showed by experiments that some parasites of fish live not only in those fish, but for a part of their existence in certain water-fowl; and this extraordinary law, which may be called after De Barry's term slightly changed, the law of metaxeny, was proved during the middle of last century by Eschricht, Steenstrup, and especially Küchenmeister, to apply to a large number of Platodes and Cestodes. Afterwards Leuckart, Melnikoff, and others extended the law to cover other species, including species of Nematodes. A most important case was that of the *Filaria medinensis,* the famous guinea worm of man, which was shown by Fedschenko in 1869, following a suggestion of Leuckart, to be in common with man and a water flea (Cyclops). All this constituted a discovery which was both remarkable in that it exhibited the wonderful devices of nature for propagating parasites from host to host, and was also of the highest importance to mankind (though few recognised this point at the time) because it showed us how many of our great diseases are likely to be acquired.

Let me dwell on this point for a moment. Parasites, accustomed as they are to dwell in the safe retreats of certain portions of their host's body, must be exposed to great dangers whenever they come to pass, as they must do from one individual host to another. Thus if this passage is effected merely by the egg, it is obvious that the eggs must be poured out in immense numbers to compensate for their immense destruction outside the body of the host; since it would always be probable that only a very minute proportion of the eggs would ever find their way again into fresh hosts of the proper species. In order to avoid these difficulties, nature, I presume through an infinite period of evolution, has enabled many parasites to acquire a more safe and certain route of entry—through other animals which are associated frequently with their first species of host. Thus, for instance, a parasite of dogs and cats develops also in the dog-louse, and is therefore not scattered broadcast from the dog and the cat over the surface of the earth, but is retained alive in close proximity to the bodies of those animals. Remember that nature is as solicitous for parasites as for the higher animals which contain them. She thinks no more of man than of the minute germ which infests him. From her open hand fall innumerable species, and she endows them all with equal powers of looking after themselves and their own interests. It is not in the interest of parasites to be wasted abroad. It is in their interest to be brought again as quickly as possible to the host in which evolution has formed them to live—and that is why this wonderful law of metaxeny holds good. It must be remembered, of course, that no species of parasite should be allowed to develop in excessive numbers in the same individual host, because this would result in the death of the latter, and therefore also of the former. The parasite must therefore find some means of transference at some stage in its life-history; and that route must be the most expeditious possible. This most expeditious route will often be, as I have said, through another species of animal connected in its habits with the original host.

Following upon the discovery of Fedschenko, Manson in 1877 showed that the embryos of another Filaria of man (*Filaria bancrofti*) develop in a species of mosquito, probably a Culex. The life-cycle of this parasite, up to the point to which he demonstrated it, was closely similar to that demonstrated by Fedschenko for *F. medinensis*; and Manson did not complete the story. Now, however, other important discoveries were made, which showed that animal parasites do not by any means belong only to the zoological groups of the Cestodes, Platodes, and Nematodes, but that many of them are unicellular. Thus Leuckart established the protozoal order of the Sporozoa; Lankester and others discovered Trypanosomes and Hæmogregarines; Davaine discovered Cercomonads, and Lösch discovered the group of parasitic Amœbæ. Lastly, in 1890, Laveran made the most important discovery that malaria is associated with a minute protozoal parasite of the blood; and his observations were followed by those of Danilewski and others, who showed that similar parasites are to be found in many animals. All this extended the catalogue of animal parasites over a vastly larger field than was known to the ancients; and the morphology and life-history of the parasites in the known hosts were elaborated by numbers of workers, who also succeeded gradually in connecting them with some of the most important diseases which inflict man and animals. Thus it was gradually shown that Amœbæ are the cause of one form of dysentery and abscess of the liver; that Trypanosomes cause the deadly nagana of domestic animals in Africa, and the equally deadly sleeping sickness of man, besides many other maladies of animals of numbers of species. Ankylostomes were proved to cause miner's anæmia, which also was shown to be prevalent through vast areas of the tropics, by no means only among miners. The Trematodes called Bilharzia were shown to produce a terrible form of cystitis in Egypt and elsewhere. *F. bancrofti* were proved to produce elephantiasis and a number of other maladies which are very common in the tropics. Simultaneously malaria was seen to be caused by at least three different species of the group discovered by Laveran.

At the same time, of course, as I have said, the habits of all these parasites in the hosts in which they had been found were being minutely examined. But up to the last decade of last century we still could form scarcely any definite idea as to how the protozoal parasites pass from one individual host to another. The law of metaxeny which had been proved to apply to many of the larger parasites had not been extended to the smaller ones. In 1889, however, Smith and Kilborne discovered a small parasite called Piroplasma in the blood of cattle suffering from Texas fever; and, more than that, showed that in some mysterious way the infection is carried from ox to ox by means of certain cattle ticks—though they did not demonstrate in any way that these parasites undergo a metaxynous stage of development in the ticks, and indeed failed to find them at all in these arthropods. In 1896 also Bruce made his famous discovery that the Trypanosomes of nagana are conveyed by certain tsetse-flies, but supposed that the carriage is a mechanical one. And there the matter rested until the solution of the malaria problem opened a new field.

We now turn to the subject of malaria. Economically, as well as medically, it is certainly the most important disease in the tropics, perhaps in the world.

It is found almost everywhere in hot climates, and even in most temperate climates during the summer. From statistics we find that as a broad general rule in malarious countries about one-third of the total population suffers from attacks every year, and also that about one-third of the admissions to hospital and attendances at dispensaries are due to malaria. But these figures are merely based upon records, and do not cover the enormous additional number of patients who remain untreated. Thus we know that the malaria-parasites or malarial enlargement of the spleen can be found in native children in malarious countries to an enormous extent, reaching 100 per cent. in very insalubrious spots. The case mortality is only about 0·5 per cent., but the prevalence of the disease is so extremely great that the total mortality caused by it makes an addition to the general mortality of anything up to 10 per mille, or even 15 per mille; and the malady complicates all other diseases in the tropics in a way which renders them more difficult to treat. In India alone it has been officially estimated that the total deaths from malaria average about 1,300,000 a year in ordinary years, and may reach a much higher figure during years of epidemic prevalence. Thus the total bill of annual mortality and sickness which King Malaria presents to the human race is something enormous.

Hence the development of the human race, especially in warm countries, has long demanded that we should ascertain exactly how this plague is propagated and should endeavour to find how best it may be prevented. It is remarkable that even more than five hundred years before Christ the ancients certainly were acquainted with one great law, namely, that malaria is connected with stagnant water, such as marshes; and there are good grounds for believing that Empedokles of Sicily actually delivered Selinus from malaria by draining its marshes or by turning two rivers into them. This knowledge seems to have been generally held since ancient times, though it must have been acquired quite empirically; but Varro and Columella, at about the time of the Christian era, actually suggested that the disease is in some way connected with insects which breed in marshes. In more modern times, however, malaria has been ascribed to noxious vapours given off by stagnant collections of water—the hypothesis evidently being that the poison is some kind of chemical one. I have mentioned that in 1880 Laveran discovered that the disease is due to certain protozoal parasites in the blood. When this fact was accepted ten years later, many observers at once rushed to the conclusion that these parasites have an extra corporeal existence in marsh water, and actually attempted to demonstrate this by producing infection in healthy persons by such water brought from malarious localities. The experiments of Agenore Zeri (1890) are to be particularly mentioned. He gave water from the Pontine marshes persistently to a number of persons orally or in spray, or by clyster—but entirely without result. At the same time many thought that the poison may lie, not only in stagnant water, but generally in the soil of warm countries—this being called the hypothesis of the telluric miasma; but, of course, this was merely a hypothesis which did not rest upon any observations or experiments. Even ten years after Laveran's discovery we were still completely ignorant as to how the malaria parasites enter the body. We might search for them in marshes and soil; but the search was likely to prove extremely difficult, because all water and soil is full of innumerable different organisms, and it would have been no light task to ascertain which of all these are really responsible for the disease among men, especially since Zeri had shown how difficult it was to produce infection by means of water in bulk.

At the same time, however, the hypothesis originally but vaguely mooted by Varro and Columella had been gaining ground. Indeed, Lancisi had repeated the same speculation in 1717, and seems actually to have suspected mosquitoes and to have studied them. So late as 1881 several theorists repeated this conception, though on studying their statements I think that little value is to be attached to them. In 1883, however, Dr. A. F. A. King wrote a most able paper on the subject, in which he gives no fewer than nineteen reasons why mosquitoes are likely to carry malaria. He thought that the insects bring the poison from the marsh and inoculate it into men. Many of his reasons are good, but others are now seen to have been untenable—and, in any case, he gave no experimental evidence. Next year, Laveran himself and Robert Koch independently enunciated the same speculation, but gave few reasons and no experiments in support of it. Ten years later, however, Manson repeated the hypothesis, but in a different form. He depended less upon the epidemiological evidence cited by King than upon certain parasitological evidence which occurred to himself. By this time (1894) the parasites of malaria had been very carefully studied, and were shown to possess, not only certain forms which provide for their propagation in the human host, but also other forms which, when the blood is freshly drawn, emit several so-called flagellated bodies. These latter forms had really led Laveran to his discovery, but their zoological significance still remained quite unexplained, and while some writers thought that they had some special significance, others believed them to be merely the result of death *in vitro*. Manson now urged that the flagellated bodies given off from these forms are really flagellated spores; that when mosquitoes ingest blood containing these forms, the flagellated spores escape in the insect and enter its tissues, where they ripen into some further unknown stage. Then, he thought, the insect dies two or three days later on the surface of the water, and this later stage of the parasites enters the water, and finally rises in the marsh mist to infect man. Obviously therefore Manson's hypothesis was quite different from King's; the former thought that mosquitoes derived the parasite from men and transferred it to the marsh, while King though just the opposite. Neither really reached the wonderful truth: both were half right, both half wrong. One cited parasitological and the other epidemiological evidence; and neither attempted experimental verifications.

Nevertheless, all these hypotheses, including those of the telluric miasma, were necessary for the laborious experimental inquiry which was now evidently demanded in the supreme interests of human life and health. I gather from what I have been told that my own work on the subject may prove sufficiently interesting to students to be worthy of mention here. I was first drawn to the malaria problem in the year 1889, when I observed during active service in Burma that the prevalence of malaria did not at all accord with the theory of the telluric and marsh miasma; and my doubts were strengthened during subsequent years by careful thought and study. If the poison is given off in an aerial form either from water or from soil, the disease ought to be almost uniformly distributed. Such, however, is not the case, and it really occurs principally in very small spots or pockets, generally in close proximity to stagnant water. Thus in one station where I afterwards served, my regiment was severely inflicted, while other regiments, scarcely a mile distant, remained almost entirely free. I was therefore very dissatisfied with this hypothesis, and being acutely alive to the great importance of the problem, I determined to study it carefully. In 1894 Manson acquainted me with his hypothesis, and I then remembered that Laveran had said the same thing; but I was not aware of King's paper, or of the remarkable researches on Piroplasma by Smith and Kilborne.

In 1895 I attacked the work experimentally at Secunderabad in India, and determined first to adopt the mosquito speculation as a working hypothesis, and then to study other hypotheses if it failed—though I was much impressed by the former. The whole history of my work has been fully given in my Nobel Lecture, published in England by the Journal of the Royal Army Medical Corps (1905); and I need mention here only the salient points. For more than two years I caused mosquitoes of the genera Culex and Stegomyia to feed on patients containing malaria "crescents," which were the proper forms for transmission according to Manson. But my failure was complete, and indeed it was impossible to follow what he thought were flagellated spores in the insect's tissues.

I then adopted another technique, which was to compare insects of the same species which had been fed on malarial blood with those which had not been so fed, and to see if I could find any particular parasites in the former after they had been kept alive for some days. Many hundreds of insects were studied completely in this manner, and more than a thousand incompletely; but my failure was still complete. I obtained, however, a close practical experience of the insect's tissues, and learnt much about some common parasites which they possess. I also endeavoured to infect healthy persons by means of water in which presumably infected mosquitoes had been allowed to die, as Manson thought that such water would infect; and, lastly, I worked at a hypothesis of mine, that infected mosquitoes might carry infection by their bites, and Mr. Appia, assistant-surgeon of my hospital at Bangalore, kindly submitted to be bitten by many such insects in 1896. The result still remained quite negative. We now know the reason: the species of insect with which I was working were the wrong species. In 1907, however, I observed another variety, which I called dappled-winged mosquitoes, and which everyone now knows were Anophelines. I first saw these in an intensely malarious quarter near Ootacamund, where I myself acquired malaria during my investigations. A few months later I obtained eight of these insects in Secunderabad, and employed them for my usual experiments. Six of them died or gave bad dissections.

On August 20, 1897, I was so fortunate as to find in the tissues of one of these insects, four days after it had been fed upon a case of malaria, certain bodies which I had never observed in mosquitoes before. These contained the characteristic pigment of the malaria parasite. Next day, August 21, I found the same bodies in the last mosquito of my batch of eight—only they were now larger and more definite. To those who had not worked at the subject, such evidence might appear slight indeed; to me, after years of toil and thought, the evidence was immensely strong. A little later I found the same bodies in two more mosquitoes, and knew that I was on the right track; I felt that the two unknown quantities of this complex equation had been simultaneously found—the species of mosquito which carries malaria, and the position which the parasites take in its tissues, namely, the wall of the intestine.

Now, after seventeen years, I may perhaps be allowed to mention this point in order to encourage those students who, as I was then, are toiling after the unknown. But I at least obtained success, not only by labour but also by supreme good fortune; and I believe that but for this good fortune on these dates, we should still have remained ignorant of the manner in which malaria is conveyed, and might have remained ignorant of it for the next century. Unfortunately my work was now interrupted for nearly six months, just at a point when I expected to unravel the whole history of the malaria parasites in a few weeks; and it was not until March of next year that I was able to take up the thread again in Calcutta. For many reasons I was then unable to work at the human parasites, but commenced the study of the malaria parasites of birds, which are closely similar to the former. In a very short time I was able to demonstrate the presence in mosquitoes of pigmented bodies derived from the allied parasites. These bodies were found to grow regularly during one week after the insects had been fed, to reach maturity, and to produce a number of elongated spores. Now came an intensely exciting moment. What happens to these spores? According to Manson's hypothesis, they ought to liberate themselves in the water in which the insects died; but I had now shown that the insects did not die after two or three days, as he supposed, but may live for weeks. I attempted to follow the spores in all directions through the insect's tissues, into the lower intestine, and even into the egg. On July 4, 1898, however, I observed the fact that the spores enter the insect's salivary or poison glands.

The full truth was now immediately disclosed, and proved to be far more wonderful than any of us had ever dreamed of. The parasites are not only taken from man by the mosquitoes, as Manson had supposed, and are not only put into man by the mosquitoes, as King had supposed, but both hypotheses are true, and the insect carries the parasites directly from man to man. Here then was merely another case of the great law of metaxeny, which, however, was now proved for the first time to hold good for protozoal parasites. The malaria, like many larger parasites, require two hosts for their life-cycle.

These researches mapped out step by step every detail of the transformation, and gave us a much greater logical certainty than could be obtained by isolated infection experiments. Nevertheless, such experiments were attempted immediately, and in July and August I infected twenty-two out of twenty-eight healthy birds by the means of the bites of infected Culex—thus completing the whole story in detail. True, that was done with birds' malaria, and I had only seen the first steps of the process with regard to human malaria; but, any zoologist will know that with such closely allied species, the life-cycle of one is sure to be almost exactly similar to the life-history of the other—as proved to be the case here. My work was now interrupted again, and for nearly a whole year; and it was not until August, 1899, that I was able to show directly that the human parasites have exactly the same development. Meantime, however, Koch and Daniels had confirmed my work on birds' malaria; and certain Italian workers repeated it with regard to the human parasites, even to causing infection in healthy human beings (November, 1898), three months after my similar work with birds.

A very important discovery had been meantime made quite independently by MacCallum and Opie in America (1897), who showed that the bodies which Manson had thought were flagellated spores, were really sperms. Thus the large pigmented cells which I had found in mosquitoes at the same date were really fertilised macrogametes. This gave a much more correct zoological interpretation to my phenomena; but did not otherwise disturb the history which I had ascertained.

This then was the result obtained. Let me summarise it briefly. From the time of the Romans, we were aware that the malarial fevers are connected with marshes and stagnant water in warm countries. Later, when it was seen that the disease is not confined only to the proximity of marshes, the theorists conceived that there is a telluric poison which causes malaria, and is especially abundant in damp places. All this was a very general proposition; and in order to prevent the disease, it was necessary to undertake very extensive drainage. Now, however, the new knowledge obtained enabled us to particularise the exact route of infection. We believe no longer that the poison is spread uniformly in the air of warm countries, but know that it is always contained in the minute bodies of certain insects, and, more than that, in the still more minute salivary glands of those creatures. Here then, science had given us knowledge which could not fail to be of immense practical importance to the world.

The discovery of the full life-cycle of the parasites enables us, not only to exercise the route of infection, but to determine exactly which species of mosquitoes are concerned. My failures with numerous undetermined species of the genera Culex and Stegomyia had shown that these are probably innocuous as regards malaria; and my ultimate success with certain Anophelines had shown that these were inculpated. Since then, the work of many observers has proved that, out of about five hundred Culicidæ only about twenty species carry malaria, and that all these belong to the Anophelines. So that for the prevention of malaria we are not obliged to deal with mosquitoes in general, but only with particular species.

Still further, the knowledge so obtained enabled us to study exactly the habits of the culpable species. In fact, I necessarily began such studies during the whole of my researches. The genera Culex and Stegomyia breed most commonly in artificial collections of water round houses; but I saw as early as 1897 that the dappled-winged mosquitoes (Anophelines) breed principally in different sites; that is, chiefly in natural collections of water, such as marshes, puddles, streamlets, and the edges of lakes, ponds, and rivers. This had been known before in the case of certain species; but I now saw the great epidemiological and sanitary bearing of the phenomenon. The reason why malaria is connected with marshes was now fully established by quite independent work. Humanity had explained the fact by supposing that the poison of malaria itself rises from the marsh; it was now seen that it is not the poison itself that rises from the marsh but the carrier of the poison. The net result was the same, except that we now knew not only the source of the poison but the exact method of transference. After all, humanity had reached the truth by empirical observations made during thousands of years; but science, in confirming those observations, has brought them to a fine point of exact theory.

But these were by no means the only fruits obtained. To return to our military parallel, when a commanding position of the enemy is carried, victory extends to a large area round it. The principal function of men of science is not merely to observe, describe, and catalogue phenomena, but, above all, to solve difficult problems; and the solution of one such problem frequently gives us the solution of many more. Such has proved to be true also in this case; for so soon as we had solved the malaria problem we were able to apply the same theorem to a number of other diseases. As already stated, Manson had shown in 1879 that the embryos of *F. bancrofti* can live in certain species of Culex—but he had not shown how they pass back from these insects to man. Now, however, James and Low, working independently, showed that the embryos enter the insect's proboscis, thus suggesting that they return into the human circulation by a route similar to that which is used by the parasites of malaria, and this work has been well followed up by Bahr and many others.

Another discovery, concerned with one of the most important of human diseases, namely, yellow fever, was made by Reed, Carroll, Lazear, and Agramonte during the last days of last century. Without knowing the causative agent of that disease, they yet showed by direct experiments on human beings that the infection is carried directly from man to man by another species of mosquito, *Stegomyia fasciata*, or *calopus*. It had long been stated by epidemiologists that malaria differs from yellow fever in that the former is connected with damp and decaying vegetation and the latter with insanitary conditions round houses. The former hypothesis was verified by the observation that Anophelines breed in terrestrial waters, and the latter was now explained by the fact that Stegomyia breed in artificial collections of water round houses. A little later Graham gave strong evidence in favour of the theory that dengue fever is carried by a species of Culex.

Thus mosquitoes have now been incriminated as the carrying agents of no fewer than four important disease of man. But this is by no means all. I have mentioned that before my work Bruce incriminated *Glossina morsitans* as the carrying agent of nagana; and he and others now showed that the deadly sleeping sickness of Africa is carried by other tsetse-flies. Various Spirochætes, especially that of tick fever, have been shown to be conveyed by ticks. A peculiar type of comparatively mild fever of which the cause, like that of yellow fever, is still unknown, has been proved to be conveyed by sand-flies. Several diseases of animals have been proved to possess a similar history; and others, both of animals and men, are suspected to lie in the same category. Perhaps, however, the most important and dramatic result was that obtained in the case of plague —the most terrible of epidemic diseases, the wonder and the despair of humanity since the beginnings of history, the scourge which was so often attributed to the direct action of God. It is due really to the rat flea. And this discovery signals another advance, because plague is, as we all know, due, not to an animal, but a vegetable parasite; and we therefore see that bacteria also may adopt precise routes of entry. A similar case is that of Mediterranean fever, which is carried principally by the milk of infected goats; and leprosy (another supposed scourge of heaven) has been attributed to the bites of bed-bugs; while some are even beginning to think that measles is due to fleas.

Gentlemen, I have now completed my task. We have seen at least another instance of how strongly recent advances in science bear upon medicine—how they confirm facts previously guessed at, achieve victories formerly undreamed of, and establish great theorems which will be of value to humanity so long as civilisation exists. But they affect not only the theory and the treatment of disease, but, what is perhaps still more important, its prevention; and it is especially in this line that the new theorems affect us. A whole great epidemiological group of diseases has been separated out, the so-called insect-borne diseases, and they are perhaps on the whole the most important, at least in the tropics. But, more than that, these discoveries give us practical methods of prevention, which may be summed up in the two words—no vermin. We now have a great sanitary ideal put before us: so to manage our habitations, villages, towns, and cities that the vermin in them shall be reduced to the lowest possible figure. Scores of entomologists and medical men are now dealing exactly with the habits of these creatures and showing us how to effect the required object. It demands only intelligence, energy, and organisation on the part of administrators. Unfortunately these qualities are not always forthcoming, and administration often lags years behind the dictates of science. Although fifteen years have now elapsed since many of the facts which I have described were discovered, I think that I may say after constant study of the subject, and with all due consideration, that mankind has hitherto not effected more than about one-tenth of the improvement of health which it might have effected already if it had put its heart into the business.

When I had completed my work in 1899 I had fondly dreamed that a few years would see the almost complete banishment of malaria from the principal towns and cities in the tropics; that those benign climates and those beautiful scenes would be almost rid at once of a scourge which has blighted them from time immemorial. In this I have been disappointed. True, much has been done in certain places, as in Panama, Ismailia, Italy, West Africa, and parts of India and the Malay States, and in some other spots; but much more might have been done had we remained fully alive to our opportunities—and our duties. It is not the fault of science that we do not fully utilise the gifts which she gives to us. None of us here will live to see the full fruition of those gifts in this particular case; but we have at least seen the beginning, and may believe that our children will reap the profit.

But it is ever thus with science. Her slaves are like labourers condemned to drive tunnels through mountains—working, perhaps for years, in darkness, and oppressed by the immense spissitudes of nature above them; but always encouraged by the hope that at any moment they may emerge into the sunlight and upon the vision of a new world. May I conclude, as appropriate to the subject of this address, with four lines which were written years ago by one who was then toiling at the researches here described and in the darkness of the most utter failure—at work, moreover, for which he had little liking or ambition. They may encourage others who are now in a like case. Writing generally of the sublime spirit of inquiry he said:—

> Thee most we honour, thee
> Great Science. Hold thy way.
> The end thou canst not see;
> *But in the end, the day.*

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

EDINBURGH.—The election of the lord rector in each of the four Scottish Universities is one of the great events in a student's life. As a rule the candidates are chosen on account of their political eminence, and the election runs on purely party lines. For ten days preceding the election proper the Conservatives and Liberals vie with one another in the issue of posters, pamphlets, and cartoons. They raid each other's temporary offices at all hours of night and day; and in Edinburgh University when the great day of the election comes and the votes are being recorded in the various class-rooms, there is a gigantic tussle in the quadrangle so as to gain and hold a certain position of vantage below the clock. A torchlight procession finishes the day's doings. Early in the summer the two parties among the Edinburgh students chose Sir John Simon and Sir Edward Carson as their candidates, and had affairs developed normally there would have been very lively times. The shadow of the war, however, stayed the coming strife, and with great wisdom the leaders of the Liberal and Unionist Associations agreed to invite as their lord rector an eminent man of no political party. Their choice fell on Lord Kitchener, himself an honorary graduate of Edinburgh University. A new lord rector is chosen every three years. He represents the students on the University Court, the governing body of the University, and when present presides at the meetings of the Court. This, however, is a comparatively rare occurrence. His one imperative duty is to address the students of the University once during his tenure of office. The addresses of Lord Kitchener and of President Poincaré, who, as announced last week, has been elected rector of the University of Glasgow, will be looked forward to with great interest.

SHEFFIELD.—The council of the University has made the following appointments:—Mr. Wilfrid Vickers (Manchester), to the post of junior lecturer in education and assistant-master of method; Mr. H. J. Davies, to the post of demonstrator in engineering; and Mr. F. Orme, to the post of demonstrator in non-ferrous metallurgy.

The council of the University, realising that under the present exigencies of trade, manufacturers will be more than ever faced with problems requiring scientific solution, has approved the formation of a University Scientific Advisory Committee to offer assistance, under conditions arranged to safeguard the interests of the consulting profession, to manufacturers carrying on processes within the Sheffield University area. From applications already received, there is undoubtedly a big field for work in front of the committee.

MR. WINSTON CHURCHILL has been unanimously adopted as candidate for the rectorship of the University of Aberdeen, and will be returned unopposed on November 7.

A COURSE of six lectures on chemistry, beginning on November 16, is to be given at the Royal Academy of Arts, by Prof. A. P. Laurie, professor of chemistry in the academy. The lectures will be given on Mondays, Wednesdays, and Fridays, at 4 p.m. The subject of the first lecture will be the present condition and the pigments and mediums used in painting the Royal Academy diploma pictures. Future lectures will deal with modern pigments, mediums, oils, varnishes, methods of wall painting, the theory of colour, and the chemistry of building materials.

THE "Professional Classes War Relief Council" has issued an appeal for funds. Representatives from the chief professional institutions with representatives of the principal societies organising relief have united to form the council, so that it is acquainted with the circumstances and needs of each profession. The intention is to assist by advice and indirect help rather than by monetary assistance. The council does not intend to interfere in any way with the work of the committees controlling the various benevolent funds, but it thinks that considerable advantages will flow from bringing into close touch the professional institutions and the societies organising relief. The council will also be able to organise special kinds of assistance which will cause those funds to go further and do more ultimate good than would be possible without co-operation. The main object will be to bridge over the temporary difficulty caused by the war and to pave the way to permanent profitable employment. Since there is no other organisation or general fund to meet this kind of distress, the need for such a fund is very great. The chief forms of assistance arranged are in matters of education, training, emigration, maternity aid, and temporary employment, all of which are to be worked under separate representative subcommittees of men and women whose capabilities fit them especially for dealing with their special departments. It is necessary to form a central fund to carry on the work, this fund being used to maintain the forms of assistance proposed; to help those members of professions which have no benevolent funds; to provide assistance for the families of professional men who have given up all to enlist for the service of their country. All those who have this need at heart are invited to send donations to the treasurer, Professional Classes War Relief Council, 13 and 14, Prince's Gate, S.W. Cheques to be crossed Messrs. Coutts and Co.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, October 27.—Prof. E. A. Minchin, vice-president, in the chair.—E. **Heron-Allen** and A. **Earland**: Foraminifera of the Kerimba Archipelago, obtained by Dr. J. J. Simpson in the years 1907–8. The area is new so far as the Foraminifera are concerned, the only records in any way approximating to it being the species described by d'Orbigny in 1826, by Brady in 1876 and 1884, by Möbius in 1880, and by Egger in 1893, from material which was collected from adjacent areas to the east of Madagascar, and off Mauritius and the Seychelles. The material consisted of fine siftings from dredgings, and having but few molluscan fragments and stones the larger adherent forms are poorly represented, but 470 species and varieties have been identified, including two new genera, and twenty-eight new species and varieties. The general facies is strikingly similar to that characteristic of Australian, Torres Straits, and Malay gatherings. The problem of distribution thus raised is obscure, the intervening ocean being abyssal, while the species now recorded are all shallow-water types. Many of the specialised forms common to these widely separated areas do not apparently occur in similar dredgings from intervening coasts, such as the Red and Arabian Seas. No doubt the equatorial current, which traverses the Indian Ocean from E. to W. and impinges on the African coast in our area, is primarily responsible for this phenomenon.—T. H. **Withers**: A new Cirripede. The description was based on a number of disconnected valves from the Chalk of Surrey and a complete specimen from the Chalk of Hertfordshire. Except for three valves referred to a new species of *Scalpellum* (*sensu lato*), the whole of the material belongs to a remarkable new asymmetrical Cirripede which differs from Verruca in the more primitive structure of the valves, in the presence of two lower lateral valves on the rostro-carinal side, and in the absence of interlocking ribs. This species represents the ancestral type from which has arisen the recent group of asymmetrical sessile Cirripedes forming the family Verrucidæ, and in its structure clearly shows its origin from the symmetrical pedunculate Cirripedes of the family Pollicipedidæ. It presents further evidence that the sessile condition was arrived at independently on several different lines of descent during the evolution of the Cirripedia.—W. L. **Distant**: Report on the Rhynchota collected by the Wollaston Expedition in Dutch New Guinea.

Challenger Society, October 28.—Dr. S. F. Harmer in the chair.—Dr. E. J. **Allen**: The artificial culture of marine plankton diatoms. Experiments were described in which it was attempted to grow cultures of the diatom *Thalassiosira gravida* in a medium containing only pure chemical salts dissolved in doubly distilled water, the medium having a composition as nearly as possible that of natural sea-water, with the addition of Miquel's nutrient solutions. In such purely artificial solutions little growth took place, but if a small percentage, even less than 1 per cent., of natural sea-water were added, large and vigorous cultures were obtained. There are reasons for supposing that this is due to the presence in the natural sea-water of minute traces of an organic substance which acts as a growth-stimulant. Provided that the small percentage of natural sea-water be present, the amounts of the various salts constituting the artificial sea-water, as well as the total salinity of the mixture, can be varied within wide limits without much detriment to the cultures.

MANCHESTER.

Literary and Philosophical Society, October 6.—Mr. Francis Nicholson, president, in the chair.—R. L. **Taylor** and Prof. Haldane **Gee**: Some original pen-and-ink diagrams used by Dalton. The uncertainty in Dalton's mind as to the number of atoms present in water, ammonia, carbon dioxide, and other compounds is faithfully reflected in some of the diagrams, and his attempts to depict the constitution of these and more complex bodies are full of interest.

October 20.—Mr. Francis Nicholson, president, in the chair.—Prof. S. J. **Hickson**: Sea-pens from the Malay Archipelago.—Dr. J. Stuart **Thomson**: Sea-pens from the Cape of Good Hope. These Pennatulaceæ were dredged off the coast of South Africa by the Cape Government trawler *Pieter Faure* during the ten years 1898–1907. Numerous species of scientific interest were collected, amongst which was *Cephalodiscus gilchristi*, an invertebrate having affinities with vertebrates. The collection of South African sea-pens is interesting, not so much because of the discovery of new species as on account of the fact that variations in certain species have been found which link genera together. One fine phosphorescent form, *Anthoptilum grandiflorum*, grows four or five feet in height, and is of a brick-red colour. It occurs in abundance at certain localities, probably forming dense miniature forests on the sea floor. The marine fauna of South Africa may be described as cosmopolitan in character.

PARIS.

Academy of Sciences, October 19.—M. P. Appell in the chair.—Gaston **Darboux**: A proposition relating to linear differential equations of the second order with two independent variables.—Pierre **Duhem**: The hydrodynamical paradox of Dalembert.—Edouard **Heckel**: Male castration of the giant maize of Serbia.—Comàs **Solà**: Photographic observation of a comet. The comet was found by its record on a photographic plate exposed October 17. It is probably identical with the comet discovered by Lunt at the Cape of Good Hope on September 18.—Ernest **Lebon**: A new table of divisors.—Alfred **Angot**: The earthquake of October 3, 1914. From the seismograph installed at the Parc Saint-Maur Observatory the epicentre was calculated to be 2600 kilometres distant, in Asia Minor. The epicentre proved to be only 150 kilometres from the calculated spot.

BOOKS RECEIVED.

Horses in Warfare. By E. Bell and H. Baillie-Weaver. Pp. 14. (London: Animals' Friend Society.)

Annual Amount and Distribution of Rainfall in the Philippines. By Rev. M. S. Masó. Pp. 42. (Manila: Bureau of Printing.)

Index to United States Documents relating to Foreign Affairs, 1828–61. Part i., A–H. Pp. 793. (Washington, D.C.: Carnegie Institution.)

North American Anura: Life-Histories of the Anura of Ithaca, New York. By A. H. Wright. Pp. 98 + plates xxi. (Washington, D.C.: Carnegie Institution.)

A Mountain Rain-Forest: a Contribution to the Physiological Plant Geography of Jamaica. Pp. 110. (Washington: Carnegie Institution.)

Farm Accounts. By C. S. Orwin. Pp. 209. (Cambridge University Press.) 3*s*. net.

Panama: The Canal, the Country, and the People. By A. Bullard (Albert Edwards). Revised edition. Pp. xiv+601. (London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

South-Eastern Agricultural College, Wye. Third Report on the Cost of Food in the Production of Milk, in the Counties of Kent and Surrey. By C. H. Garrard. Pp. 82. (Wye: South-Eastern Agricultural College.)

Proceedings of the Cambridge Philosophical Society. Vol. xviii. Part 1. (Cambridge University Press.)

Journal of the College of Agriculture, Tohoku Imperial University, Sapporo, Japan. Vol. vi. Parts ii. and iii. (Sapporo.)

Bulletin of the Imperial Earthquake Investigation Committee. Vol. vi., No. iii. Vol. vii., No. i. Vol. viii., No. 1. (Tokyo.)

Pumping by Compressed Air. By E. M. Ivens. Pp. vi+244. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12*s*. 6*d*. net.

Foundations. By Prof. M. A. Howe. Pp. vii+110. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5*s*. 6*d*. net.

Department of the Interior. U.S. Geological Survey. Mineral Resources of the United States. Calendar Year 1913. 21 Publications. (Washington: Government Printing Office.)

Department of the Interior. U.S. Geological Survey. Water Supply Paper, 327, 345 E, 345 F. Bulletin 548, 550, 574, 579, 581 B. (Washington: Government Printing Office.)

Department of the Interior. U.S. Geological Survey. Professional Paper 83. The Middle Triassic Marine Invertebrate Faunas of North America. By J. P. Smith. Pp. 254+plates xcix. (Washington: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. lxii. No. 3. Hodgkins Fund: Report on European Aeronautical Laboratories. By Dr. A. F. Zahm. (Washington: Smithsonian Institution.)

U.S. Department of Agriculture. Bureau of Biological Survey: North American Fauna. No. 36. (Washington: Government Printing Office.)

Proceedings of the American Philosophical Society. Vol. liii. Nos. 213, 214. (Philadelphia: Philosophical Society.)

Leland Stanford Junior University Publications. The Birds of the Latin Poets. By Prof. E. W. Martin. Pp. 260. Acceleration of Development in Fossil Cephalopoda. By Prof. J. P. Smith. Pp. 30+xv plates. A Morphological Study of Some Members of the Genus Pallavicinia. By Prof. D. H. Campbell and F. Williams. Pp. 44. (California: Stanford University.)

DIARY OF SOCIETIES.

THURSDAY, November 5.

Royal Society, at 4.30.—Acquired Radio-Activity: Sir William Crookes. Luminous Vapours Distilled from the Arc, with Applications to the Study of Spectrum Series and their Origin, II.: Hon. R. J. Strutt.—The Production of Neon and Helium by the Electrical Discharge: Prof. J. N. Collie, H. S. Patterson, and I. Masson.—The Flow of Viscous Fluids through Smooth Circular Pipes: Prof. C. H. Lees.—Quantitative Measurements of the Absorption of Light. I.: The Molecular Extinctions of the Saturated Aliphatic Ketones: F. O. Rice.—The Ignition of Gases by Condenser Discharge Sparks: Prof. W. M. Thornton.—The Spark Spectrum of Nickel under Moderate Pressures: E. G. Bilham.

Child Study Society, at 7.30.—Classification of the Deaf Child for Educational Purposes: P. M. Yearsley.

MONDAY, November 9.

Royal Geographical Society, at 8.30.—The Geography of the War: Hilaire Belloc.

TUESDAY, November 10.

Zoological Society, at 5.30.—Exhibition of Photographs Illustrating the Life-history of the Gannet: L. Balfour.—Lantern Exhibition showing the Differences between the Pine and Beech Martens: R. I. Pocock.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. XV.: A New Genus and Species of the Family Acoleidæ: Dr. F. E. Beddard.—Report on the Spiders Collected by the British Ornithologists' Union Expedition and the Wollaston Expedition to Dutch New Guinea: H. R. Hogg.

Mineralogical Society, at 5.30.—Albite; Its Crystal Elements, etc.: Prof. W. J. Lewis.—The Determination of the Maximum Extinction, etc., of Monoclinic Pyroxenes in Thin Sections: H. Collingridge.—Note on Calcite from the Chalk at Corfe Castle, Dorset: Prof. H. L. Bowman.—Barkevicite from Lugar, Ayrshire; and Litharge from Persia: A. Scott.—Meteoric Irons of Uwet and Angela; the Identity of Angela with La Primitiva: Dr. G. T. Prior.

THURSDAY, November 12.

Royal Society, at 4.30.—*Probable Papers:* Analyses of Agricultural Yield. I.: Spacing Experiments with Egyptian Cotton: W. L. Balls and F. S. Holton.—The Fixation of Arsenic by the Brain after Intravenous Injections of Salvarsan: J. McIntosh and P. Fildes.—The Production of Anthocyanins and Anthocyanidins. II.: A. E. Everest.—Living Observations on the Life-Cycle of a New *Flagellate-Helkesimastix Faecicola*, together with Remarks on the Question of Syngamy in the Trypanosomes: H. M. Woodcock and G. Lapage.—The Antagonistic Action of Carbon Dioxide and Adrenalin on the Heart: S. W. Patterson.

Institution of Electrical Engineers, at 8.—Cables: C. J. Beaver.

Mathematical Society, at 5.30.—Annual General Meeting. Presidential Address: Mathematical Research; Prof. Love.

FRIDAY, November 13.

Alchemical Society, at 8.15.—The Movement of Alchemical Research in France: Actual Traces of Transmutation: W. de Kerlor.

Royal Astronomical Society, at 5.

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THURSDAY, NOVEMBER 12, 1914.

THE PLACE OF SCIENCE IN INDUSTRY.

AN interesting article, by Mr. W. H. Dawson, appears in the November number of the *Fortnightly Review,* under the heading "The Campaign against German Trade." It is there given as the opinion of one of "the six best known industrial leaders of Germany" that "England's days as an industrial country are over. Your industry will pass more and more into the hands of the younger nations, and you will become simply a trading country." The author of the article goes on to point out that the lesson of Germany's success will not be learned "if we refuse to grasp the fact that its people have brought to industrial and trading pursuits just the same habits of method, thoroughness, concentration, and seriousness which mark them in other departments of life." He attributes the success largely to the co-operation between science and industry which prevails in Germany. This cannot be denied; but a further reason for Germany's rivalry, so far as it is successful, is afforded by a quotation from a speech made in July, 1912, by the Prussian Minister of Commerce; it is that the desire of manufacturers is, without exception, that the import duties on competitive articles may be kept as high as possible, and the foreign duties on articles exported from Germany as low as possible. It is also emphasised by the writer of the article that German employers have never had to encounter systematic opposition on the part of the workers, as has so often been the case in this country. Again, the German cultivates methods of distribution much more sedulously than does the Englishman; he never forgets that he exists for his customers; and the larger firms, or combinations of them, keep highly paid agents in every important market. The Germans are also greatly aided by their banks, which advance money on the security of orders.

Mr. Dawson does not believe that changes in fiscal regulations alone would put the British manufacturers in the same favourable position as the German, although he does not deny the advantages of a protective tariff. British trade must be supported by foundations of brains, science, and education, if it is to succeed.

While the truth of the general scope of the article, of which an abstract has been given, cannot be denied, it appears doubtful whether British manufacturers would care to adopt all the methods of their competitors. The colour trade, to take an example, has been secured for Germany, not entirely by the training of the chemists and operatives, but by what the Germans somewhat indefinitely call "Kultur"—careful organisation. First, the management consists, not in a board of well-meaning elderly gentlemen with a works-manager in their employment, but in a board of specialists, whose business in life is to manage the factory, financially, chemically, and as engineers, and who are very highly paid for their services. Second, these gentlemen and a special staff are continuously on the look-out for any scientific discovery or invention (generally made in countries other than Germany) which can prove of advantage to their business. Third, a very large staff of men, trained in universities or in technical schools, is turned on to the problem of making such a discovery commercial, whether by securing cheap raw material, cheapening the process of manufacture, or creating a public demand for the article to be manufactured. Fourth, a legal staff is maintained, whose business it is to protect by patent all improvements, however apparently trivial, and to describe them so vaguely as to conceal them from their competitors; also to advise on means to crush competitors by expensive legal actions. Fifth, such companies are so powerful, that they can influence the central Government to protect all new developments, whether by imposing duties on articles which might possibly compete, by extending bounties to all exported products, or by securing advantages in freights to the coast, and in shipping the goods abroad. These gentlemen in some cases (not in all) have also to advise whether piracy is likely to be successful; whether it may not be possible, by infringing a patent, so to saddle an opponent with legal expenses as to break his competition. Sixth and last, agencies are maintained all over the world whereby the article is introduced to the notice of foreign purchasers, and an extensive credit system is encouraged.

Trade, in fact, is regarded in Germany as a war, in which all means of conquest are permissible. We are at present discovering, in the military operations of the Germans, the precise equivalent in war of their operations in trade. It remains to be seen whether we shall care to do business with them when a state of industry succeeds a state of war. If we are to conquer, we have the alternatives; to copy their methods; or to refuse to deal with them. Perhaps these are not exclusive; for there are many things in their methods which we might with advantage copy; and we could perhaps boycott trade conducted according to plans which we consider dishonourable or underhand. Time alone will show. But this is a fitting opportunity to consider our position; and by organisation, by co-operation among our manufacturers rather than by competition between them, and by education in science of our directors and employees, we might do much to forestall the attack which will undoubtedly again be made on our commercial position, if, at the end of the war, any prospect of recuperation is left to Germany. WILLIAM RAMSAY.

SCIENCE THE HANDMAID OF ART.

The Pigments and Mediums of the Old Masters. By Prof. A. P. Laurie. Pp. xiv + 192 + xxxiv plates. (London: Macmillan and Co., Ltd., 1913.) Price 8*s*. 6*d*. net.

THE information given in this book shows that the scientific man has come to the aid of the art expert in his endeavour to determine the period and the authorship of paintings of disputed origin. The author's previous works on "Greek and Roman Methods of Painting" and on "Materials of the Painter's Craft" indicate in what degree historical and literary research coupled with technical knowledge can be relied upon as guides in such an inquiry.

The present volume shows to what extent exact experimental investigation can be utilised to assist in this matter. The methods available are based upon an examination of the physical and chemical properties of the pigments and mediums used, and a microscopical examination of the nature of the brush work of the picture. The latter has given very interesting results, and shows that great individuality is found in the work of different artists.

The method recommended by the author for a critical examination of the brush work is to make a photomicrographic reproduction of a selected portion of the picture under a magnification of about three diameters.

The author is gradually accumulating a series of such photomicrographs, of well-authenticated pictures, and these will certainly be a valuable aid in the detection of forgeries, copies, etc. Some striking plates are shown in the book illustrating the use of such brush work enlargements, and the value of the method is well seen by a comparison of plates vi. and vii.—the former from a picture by J. A. Watteau and the latter from a copy by a good modern artist.

In addition to their use for the purpose of identification, it appears probable that such photomicrographs might be of much value for instructional purposes, as indicating the methods adopted by noted artists in developing their effects.

The first ten chapters of the book deal with the examination of the pigments and mediums. The physical character of the pigments, such as coarseness of particles, simple or mixed character, etc., may be frequently determined *in situ* under a magnification of about 100 diameters; but the removal of a minute fragment of pigment for more detailed examination is usually desirable. This may be done by making use of a microscopic gouge about a millimetre in diameter, or a complete section through the picture may be obtained by using a hypodermic needle. Full instructions are given for the transference and examination of the fragments of pigment, all tests, of course, being applied under the microscope.

The identification of the pigments and medium used in well authenticated pictures, coupled with historical information regarding the nature of the pigments in use at certain periods, makes it possible approximately to date many pictures, and the knowledge of the particular palette used by an artist, together with an examination of his brushwork, greatly facilitates a judgment in cases of doubtful authenticity.

The book is thus of much interest, not only to dealer and collector, but to the artist and historian. It is obvious, however, that the new methods of examination should be applied to valuable works of art only by such special experts as Prof. Laurie, and there is some slight danger involved in the publication of methods of sampling "old masters," even when the sample is to be taken with a hypodermic needle.

WALTER M. GARDNER.

PUBLIC HEALTH.

(1) *Preliminary Report on the Treatment of Pulmonary Tuberculosis with Tuberculin.* By Dr. Noel D. Bardswell. With a Prefatory Note by Prof. Karl Pearson. Pp. xxi + 141. (London: H. K. Lewis, 1914.) Price 6*s*. net.

(2) *Cambridge Public Health Series. Isolation Hospitals.* By Dr. H. Franklin Parsons. Pp. xiv+275. (Cambridge: University Press, 1914.) Price 12*s*. 6*d*. net.

(3) *The Bacteriological Examination of Food and Water.* By Dr. William G. Savage. Pp. x+173. (Cambridge: University Press, 1914.) Price 7*s*. 6*d*. net.

(1) TREATMENT of tuberculosis, and in particular pulmonary tuberculosis (phthisis or consumption), with tuberculin is undoubtedly tending to increase in England, and a number of

sanitary authorities have established "tuberculin dispensaries," where it may be applied to the poorer population under adequate medical supervision. On the other hand many Continental authorities view tuberculin treatment with considerable distrust. The appearance of Dr. Bardswell's report is therefore opportune, and we could have hoped that experience in the King Edward VII. sanatorium might have settled the real value or otherwise of tuberculin in the treatment of consumption. Some of the data obtained seem to be in favour of it, but Prof. Karl Pearson has examined the statistical data, and concludes that they do not show "that obvious and marked advantage of tuberculin treatment which would raise it at once above all suspicion of showing what advantage it does show, owing to selection of patients. Correction for selection may show it with a slight credit or an actual debit. . . . When all selected cases are treated as at present, we shall have no suitable control to determine whether the treatment has any real value, unless indeed we again leave it off." We notice that X-ray photographs do not appear to be a routine method of examination at this sanatorium, which is surprising, and Spengler's picrin method for staining the tubercle bacillus might be adopted with advantage.

(2) This book on isolation hospitals must be regarded as an authoritative one, as Dr. Parsons was a recognised authority on the subject. The past tense is used because the author did not live to see the work through the press, and its correction and completion was undertaken by Dr. Bruce Low. The book contains far more than its title indicates, as it really deals with the whole question of isolation for the preventive treatment of infective diseases. Thus in addition to isolation hospitals, the subjects of home isolation, eucalyptus treatment, and the law in relation to infectious diseases are fully discussed. Under isolation hospitals, the subjects of area, site, design, staffing, removal and discharge of patients, and cost are dealt with. Additional chapters are devoted to the hospital system of the Metropolitan Asylums Board and sanatoria for tuberculosis. A number of plans with descriptions of existing isolation hospitals complete the work, which should be of the greatest value to public health students and authorities.

(3) Dr. Savage has brought together into one volume a mass of valuable data relating to the bacteriology of foods, water, air, soil, and sewage, together with a description of the methods employed for examining them bacteriologically. He himself has contributed much to the subject, and is therefore able to discuss critically the value of the various methods employed, and of the data obtained therefrom. In a final chapter the determination of antiseptic and germicidal power is described, and the composition of the media employed is given in an appendix. The book is a very useful addition to the Cambridge Public Health Series, which is now being issued under the editorship of Dr. Graham Smith and Mr. Purvis.

R. T. HEWLETT.

LIGHT AND ITS ACTIONS.

(1) *Photo-Chemistry*. By Dr. S. E. Sheppard. Pp. x+461. (London: Longmans, Green and Co., 1914.) Price 12*s*. 6*d*.

(2) *Photo-Electricity*. By Prof. A. Ll. Hughes. Pp. viii+144. (Cambridge: University Press, 1914.) Price 6*s*. net.

THE interest of scientific workers in the chemical and physical changes brought about by light is shown by the number of works recently published bearing on this subject. The importance of investigations on the action of light can scarcely be over-estimated, seeing that human life is dependent on "that branch of applied photochemistry which is termed agriculture."

(1) Dr. Sheppard gives an account of the principal facts relating to photo-chemistry, and discusses the present state of the theory of the subject. The book is very unequal. So far as the facts are concerned, the description is generally clear, but in the more theoretical portions the author frequently runs amok and indulges in quasi-philosophical discussions which do not add to the lucidity of his argument. The work, unfortunately, justifies the complaints made against the literary style of many men of science. Thus on p. 229 we have a sentence containing fifteen lines, and on the following page a sentence of fourteen lines. The author has a predilection for the use of foreign words and for the introduction into his subject of new terms which are often only vaguely defined, if defined at all. We do not recognise "temps" as an English word, and do not regard *mass* and *measure* as interchangeable terms, though the author speaks of "Radiant Energy in Absolute Mass."

In spite of many faults of presentation the volume will be found useful, as it contains a large amount of matter not available in other English works. The first half of the book deals with the physical side of the subject, and includes chapters on the measurement of light quantities, the energetics of radiation, and the absorption of light. Actual light-sources are also considered, special attention being given to the light of the sun, either in its direct form or as diffused daylight. The mercury vapour lamp scarcely receives adequate recognition. The second part of the book deals principally with the chemical changes due to different forms of radiation. The author summarises his views by saying: "The conception that in photo-chemical change singular intermediate complex ions, or, specifically speaking, veritable latent light-images, are formed, appears the most promising."

(2) The account of photo-electric phenomena given by Dr. Hughes is lucid and concise. The photo-electric effect is regarded as a form of ionisation by light. Most of our information as to such ionisation has been derived from a study of the action in the case of solids and liquids, owing to the fact that in the case of gases ionisation is only brought about by light of extremely short wave-lengths. The aim of the author appears to have been to give a comprehensive view of the present position of the subject. In this he has been successful, though the result is perhaps to mar the historical setting and to deny adequate recognition to some of the earlier workers. Thus the work of Hallwachs and his pupils on the influence of contact potential on photo-electric phenomena is not referred to. The "energy law" which is emphasised in this book was established mainly by the experiments of the author and of Richardson and Compton. It expresses the fact that the maximum emission energy of a photo-electron is a linear function of the frequency of the light. This is in accordance with the quantum theory of radiation developed by Planck and Einstein, and first applied by W. Wien (whose name is not mentioned) in connection with Röntgen rays in 1907.

Both volumes contain a subject index and an index of authors. In the case of the latter volume the index of authors is far from complete.

PHILOSOPHY.

(1) *A Theory of Civilisation.* By S. O. G. Douglas. Pp. 246. (London and Leipzig: T. Fisher Unwin, 1914.) Price 5*s.* net.

(2) *Our Knowledge of the External World, as a field for Scientific Method in Philosophy.* By B. Russell. Pp. vii+245. (London and Chicago: The Open Court Publishing Co., 1914.) Price 7*s.* 6*d.* net.

(1) A READABLE and well-informed treatment of civilisation viewed as the outcome of religious belief. The various "psychic illusions" are considered—Olympianism, Orphism, Christianity, Islam, Buddhism, the ancient religion of Peru, etc.—and it is argued that each religion has elements which tend to an advance in civilisation, these elements being always irrational, for the rational and critical and selfish elements furnish no driving power except as to the individual's own well-being. In course of time disillusionment comes about; the beliefs are gradually abandoned as the intellectual powers—which have grown with the civilisation—assert themselves critically, and there is then a slide down until civilisation and the general intelligence reach such a level of degeneracy that another "psychic illusion" becomes possible. The process then repeats itself; though the author apparently thinks that the crest of each civilisation-wave is, on the whole, higher than the last, the "spirit of evolution" selecting for each successive illusion that which will yield improved results. The interesting question naturally arises as to whether, after Christianity, we shall manage to get along without illusions at all, or whether a new illusion will impose itself, as before. The author inclines to the latter opinion, but wisely refrains from detailed prophecy.

(2) This volume contains Mr. Russell's Lowell Lectures, delivered in Boston last March and April. They deal with the various idealisms—Platonic, Berkeleyan, Bradleyan, etc.—as the title implies, but there is also some acute criticism of Bergson's intuitionism, and a full analysis of the old problems of Achilles and the tortoise, and the impossibility of the moving arrow's motion. The author maintains the fresh and brilliant yet easy style which always makes his writings a pleasure to read, and though, as he says, philosophy in becoming more scientific inevitably becomes less humanly interesting, it is likely to retain devotees as long as it has such exponents as Mr. Russell.

The book is, of course, mainly logical, and the modern position is maintained. "The trivial nonsense embodied in this [Aristotelian] tradition is still set in examinations, and defended by eminent authorities as an excellent 'propædeutic,' *i.e.* a training in those habits of solemn humbug which are so great a help in later life" (p. 33).

> "The old logic put thought in fetters, while the new logic gives it wings. It has, in my opinion, introduced the same kind of advance into philosophy as Galileo introduced into physics, making it possible at last to see what kinds of problems may be capable of solution, and what kinds must be abandoned as beyond human powers. And where a solution appears possible, the new logic provides a method which enables us to obtain results that do not merely embody personal idiosyncrasies, but must command the assent of all who are competent to form an opinion" (p. 59).

BOTANY AND GARDENING.

(1) *The Standard Cyclopedia of Horticulture.* By L. H. Bailey. Vol. i, A. B. Pp. xx + 602 + plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) 25*s.* net.

(2) *Plants and their Uses.* An Introduction to Botany. By F. S. Sargent. Pp. x + 610. (London: Constable and Co., Ltd., 1914.) 5*s.* net.

(3) *My Garden in Summer.* By E. A. Bowles. Pp. viii + 316 + plates. (London and Edinburgh: S. C. and E. C. Jack, 1914.) 5*s.* net.

(4) *Some Desert Flowers collected near Cairo.* By Grace M. Crowfoot. Pp. 50 (35 plates). (Cairo: F. Diemer, n.d.) 6*s.*

(5) *Flower Favourites: Their Legends, Symbolism and Significance.* By Lizzie Deas. 2nd edition. Pp. viii + 229. (London: Jarrold and Sons, n.d.). 3*s.* 6*d.* net.

(1) THE Standard Cyclopedia of Horticulture, by Mr. Bailey is indeed a monumental work—we wish that its weight did not add force to the use of our adjective. Only the first volume is before us, but from this it will be seen how comprehensive and useful the completed work will be. It is written from the point of view of the American horticulturist and in some respects is therefore not always suitable for the English reader, but so much is of real value to all engaged in the science that its decidedly American point of view does not detract seriously from its value to the British or Colonial reader.

An admirable synopsis of the plant kingdom extending over 78 pages, is followed by a very useful key to the families and genera of plants Then comes an exhaustive list of plant names in Latin with their English equivalents, which should be found of great service. Our only quarrel with this portion is the division of the Latin words, as an aid to their pronunciation, but entirely irrespective of their formation. Surely the position of the accent would have been sufficient. How unpleasant and misleading are the following: *multíj ugus, oxyphýl lus, pentán drus, dichót omus,* and the like!

There is also a good glossary of terms.

The articles on the plants themselves are well written, and in addition there is a mass of general botanical information. Under the headings "Arboretum" and "Arboriculture," for instance, there is a disquisition of some 35 pages in double column, giving quite an exhaustive treatise on the subject. Plant weeding receives equally useful treatment. Some articles like that on flower arrangement might well have been omitted, but on the whole the book is a very useful publication, though had it been prepared for English readers they would probably have preferred a volume less discursive and more in the style of Nicholson's Dictionary.

(2) An old friend in a new dress presents certain attractions if the dress is suitable, but we object to a rather thin attempt to veil the usual form of teaching under a dull and useless cloak. Mr. Sargent sets out with the idea that botany can be best taught by approaching it from the economic side, and finds himself in difficulties because with each plant or group of plants he is in the midst of his subject before he has been able to deal with the elements. The earlier chapters which treat of plant foods, vegetables, fruits, spices, condiments, drugs, poisonous plants, etc., are very well done in their way, but the method necessarily results in a jumbling together of a heterogeneous collection of unrelated plants and masses of useful information set out in a dull and unattractive manner.

Then follows an account of certain natural orders, some treated diffusely, others very shortly, and a remarkable set of formulæ of seed plants which are fearsome to behold. We venture to think that he who seeks to derive a love of botany from Mr. Sargent's book will be in the unfortunate position of the blind man looking for the black hat.

(3) Why is it that so many people who excel in one sphere of life attempt to display their powers in directions in which they are quite unsuited? In the case of those who make books there are many sad examples of people who, however much they excel in their own particular line, are quite incapable of expressing with a pen what they can ordinarily impart with ease and grace by word of mouth. Among books dealing with gardens and gardening more than one case could be cited, but perhaps one of the most unfortunate efforts is that by Mr. Bowles in his attempt to describe his own beautiful garden. To those whose privilege it is to know the author, and who can appreciate his rare and intimate knowledge of plants and their cultural requirements, it is a matter of pain to find him in print a very Mr. Hyde by comparison.

If only he could have begun his chapters in the middle, and so obviated the terrible stumbling-block of a grandiloquent opening, things might have been better, but even in the middle of a chapter it is a severe trial to come across such a passage as this:

"Two out of our three bushes of *Buddleia globosa* reside close by where we now stand, and are providing free drinks for the bees and a delicious scent of heather-honey for my nose if I apply it to the golden cowslip-balls in miniature, after I have shaken off the bees, which might not behave kindly to my proboscis, mistaking it for a rival to their own in the honey-gathering trade.”

This, alas! is typical of many others which give a painful stab in the middle of chapters containing a great deal of interesting and valuable information.

The book is illustrated by some very fair photographic reproductions, but the coloured plates are miserable. The sad part is that Mr. Bowles has the knowledge that others seek to acquire, but an evil spirit appears to haunt him when he takes his pen to write.

The book contains a great deal of very valuable and interesting information, but the shock to the literary sensibilities of those who seek to extract the gold is almost too severe.

(4) The pictures of desert flowers will be very useful to travellers interested in the desert flora of Egypt. The photographs, especially when taken in the field, are good, and the introductory twelve pages are well written. We hope Miss Crowfoot will be rewarded by a ready sale for her book, and induced thereby to publish a further volume of pictures of the flowers of the desert. Should this be feasible a plate giving a detailed study of the flowers, fruits, and leaves of each plant, would be a useful addition to accompany the plate showing the habit of the plant in its natural conditions.

(5) “Flower Favourites” is a very pretty little book, a storehouse of quaint legend and myth relating to some forty-eight well-known flowers. Among them are such familiar plants as the rose, cowslip, speedwell, leek, and hyacinth, and in all cases numerous quotations from the poets are given which refer to the particular flowers. It is a book for which lovers of flowers will be grateful, since it has been compiled with great care, and shows that the author has a very extensive knowledge of the ancient and modern literature of plant lore. It is essentially a book to be appreciated by those whose vision penetrates beneath the surface.

> “Earth's crammed with heaven
> And every common bush afire with God:
> But only he who sees takes off his shoes:
> The rest sit round and pluck the black berries.”

OUR BOOKSHELF.

Kinetische Stereochemie der Kohlenstoffverbindungen. By Dr. A. von Weinberg. Pp. viii + 107. (Braunschweig: F. Vieweg und Sohn, 1914.) Price 3 marks.

IT would be difficult within the compass of a short notice to develop the highly speculative conception which underlies what the author terms “kinetische stereochemie.” He claims that it will eliminate the vague notions which hover round the theory of valency, and have rendered it necessary to qualify this attribute by the use of “partial” valencies, broken valencies, distributed valencies, and valency electrons.

Dr. von Weinberg has attempted to prove that chemical changes are determined by atomic motions; that these motions are rotatory and vibratory, and are closely linked to the phenomena of heat of combustion and molecular refraction. He considers that by means of this conception it is possible to solve a variety of unsolved problems, such as the structure of benzene, the phenomenon of dynamic isomerism, the asymmetric carbon, optical activity and colour.

He lays down the proposition that in all states of aggregation the atom has motion, and that the energy content of these atomic motions in organic compounds may be determined by the atomic volumes, which in turn can be estimated as heat of combustion and atomic refractivity. He further assumes that singly-bound atoms rotate or oscillate round an axis, and that doubly- and trebly-linked atoms undergo a vibratory movement. The difference in the heat of combustion of an atom when combined in an organic compound and when free as an elementary molecule is not a question of a change in chemical affinity, but of the increase or decrease in atomic motion in the two states. In the same way increase or decrease of atomic volume, as determined by the motion (rotatory or vibratory) of the combined atom, is manifested by the density of the liquid substance, *i.e.*, its refractivity. These two ideas are developed conjointly at some length, and a considerable mass of data is introduced to support the theory. We think that some of the statements are open to criticism, such, for example, as making one kind of atom in a compound responsible for the whole difference in the heat of combustion, and consequently in atomic motion and so forth. Whether these speculations, for they are pure speculations, will serve to stimulate further experimental inquiry is somewhat doubtful; but the theory is bold and suggestive, and the pamphlet is well worth perusal. J. B. C.

The Essence of Astronomy: Things Everyone Should Know about the Sun, Moon, and Stars. By E. W. Price. Pp. xiv + 207. (New York and London: G. P. Putnam's Sons, 1914.) Price 10*s*. 6*d*. net.

THE title “The Essence of Astronomy” gives a good idea of the lines on which this book has been written. The book does not pretend to be a treatise, and it deals only with the main, well-authenticated facts in a popular manner. All technical terms, mathematical formulæ, and symbols have been omitted in the text, but the last-mentioned are given on a separate page at the end of the volume.

Those who wish to read a simple and brief account of the main facts about the sun, planets, asteroids, comets, and stars (normal and abnormal) cannot do better than peruse this book. A general idea of the universe will be easily obtained, and some notion of the vast subject of astronomy will be gained. The illustrations are reproduced from some of the finest photographs ever taken, and they are well distributed and chosen. A brief bibliography of books more or less popular is given at the end; also a chronology of the main events of astronomy from very early times to 1908. With regard to the latter the author seems to think that such a table is unique or "what the compiler has never happened to see before." To take only one instance, he has evidently never seen Miss Clerke's admirable "History of Astronomy during the Nineteenth Century," at the end of which is a chronological table stating the main astronomical advances from 1774 to 1893.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Fizeau's Experiment and the Principle of Relativity.

MR. CUNNINGHAM seems determined that the principle of relativity shall assert supremacy as regards the Fizeau effect on the velocity of light, arising from motion of the transmitting medium. This is a first-order effect, while the principle of relativity was invented to account for the second order. Up to the first order the affairs of moving media hang entirely on the ascertained fundamental relations of electrodynamics; and any type of relativity which does not agree with the formula thence deduced must, if substantiated, upset our whole system of ideas.

As regards the arguments adduced: (1) is of course a slip of the pen—he is thinking of steady viscous flow in a pipe, whereas the standard measures for ordinary turbulent flow are in general agreement with the values quoted from the experiment; while as regards (2), it seems certain that the experimenters must have had before them the effect of variation of velocity across the section of the pipe, which would curve the fronts of the waves and thus broaden the interference bands, but not much if only the central part of the pipe, in which the velocity varies but slightly, is employed. The shift at the centre of the band-system would depend on the axial velocity only.

JOSEPH LARMOR.

Cambridge, November 2.

THERE was no intention in the letter to which Sir Joseph Larmor refers (NATURE, October 29, p. 226) of suggesting that the principle of relativity and the fundamental relations of electro-dynamics were at variance with respect to this matter. Certainly I have always taken them to be completely at one. But it has been raised in several quarters as an objection to both points of view that the extremely careful experiment of Michelson and Morley was not in complete agreement with theory. They found the convection coefficient for water to be 0·434 ± 0·02, while theory (taking account of dispersion according to Lorentz's formula) gives 0·451, which is very near the limit of possible error.

Sir Joseph Larmor makes it clear that the suggestions which I made as to the possible origin of the discrepancy are untenable, and, I understand, feels that it must lie in the inherent difficulties of the experiment. One of these is the determination of the axial velocity in terms of the mean. The experimental device could not be expected, I think, to give a result correct to one or two per cent., inasmuch as the pressure gradient actually measured is partly the normal pressure gradient of the undisturbed flow, and partly that due to the disturbance produced by the insertion of the gauge-tubes.

But, as a matter of fact, the discrepancy is not so great as has been thought. A recalculation from the figures and formulæ of Michelson and Morley, which Sir Joseph Larmor has now checked for me, gives for the experimental value of the coefficient 0·442, with their estimated possible error of ±0·02. Thus the discrepancy (0·009) with the value given by Lorentz's formula (including dispersion) proves to be less than half the possible error.

E. CUNNINGHAM.

Wireless Signalling for Shipping in War Time.

THE advantage which wireless telegraphy has been in enabling the whereabouts of vessels at sea to be known from day to day, is now in abeyance, I believe, on account of the war, because of the messages being liable to be read by the enemy.

But if a system of signalling false latitudes and longitudes by a code prearranged by the owners, different for each craft, and variable from day to day, easy and simple to translate by reference to the copy kept, then wireless signalling could go on as freely as before, without danger of the code being captured by the capture of any craft.

To illustrate the method of this, let us suppose a firm of owners have two ships, the *Ariadne* and *Ocean Bird*. A list of dates has been given to each captain with instructions to falsify positions on the respective dates (London time) with additions and subtractions as found in the list in opposition to the dates, thus :—

SHIP "ARIADNE."

	Lat.	Long.
Nov. 1	+14°	−21°
2	−16°	+15°
3	+30°	+20°
	etc.	

SHIP "OCEAN BIRD."

	Lat.	Long.
Nov. 1	−18°	+24°
2	−16°	−21°
3	+18°	+15°
	etc.	

The owners of these ships could interpret the wireless messages received through the exchange, and the Admiralty be quickly notified of a disappearance with approximate latitude and longitude.

A. BOWMAN.

144 Well Street, Hackney.

NOTES ON STELLAR CLASSIFICATION.

IN all my early work at Kensington (1887) on the classification of stars according to their spectra, the best basis for a classification was chiefly considered. The data available were the chemical facts obtained by a detailed inquiry into the chemical origins of the various lines and flutings, using higher dispersion and more laboratory work than were employed in other observatories.

The first and most important result obtained was that it was found necessary to divide the stars into two groups, one set increasing their temperatures while in the other the temperature was running down.

This, indeed, added a *physical* difference to the chemical ones, and there was another, for on the meteoritic hypothesis the stars getting hotter were sparse swarms of meteorites being vaporised, while those getting colder were rapidly condensing into solid bodies.

These were fundamental changes of front. Up to that time only a line of decreasing temperature had been considered. Passing over the earlier classification of Rutherfurd (1863), which was only modified by Secchi (1867), though by those ignorant of the subject he is credited with the origination of it, I may mention that in 1873 I referred to the question of temperature in a Bakerian Lecture,[1] and in 1874 Vogel brought out a considerable classification. This was also based upon a line of descending temperatures. On this classification I wrote in another Bakerian Lecture (1882)[2]:—

"The idea which underlies the classification is that a star of Class I. on cooling becomes a star of Class II., and that a star of Class II. has as it were a choice before it of passing to Class III*a*. or Class III*b*. Thus under certain conditions its spectrum will take on the appearance of Secchi's third type, Class III*a*. (Vogel); in certain other conditions it will take on the appearance of Secchi's fourth type, Class III*b*. (Vogel). There is now, however, no doubt whatever that Secchi's Class III., represents stars in which the temperature is increasing, and with conditions not unlike those of the nebulæ—that is to say, the meteorites are discrete, and are on their way to form bodies of Class II. and Class I. by the ultimate vaporisation of all their meteoric constituents. There is also no doubt that the stars included in Class III*b*. have had their day; and that their temperature has been running down, until owing to reduction of temperature they are on the verge of invisibility brought about by the enormous absorption of carbon in their atmospheres."

"Pechüle was the first to object to Vogel's classification, mainly on the ground that Secchi's types III. and IV. had been improperly brought together; and my work has shown how very just his objection was, and how clear-sighted was his view as to the true position of stars of Class III*b*."

Prof. Keeler wrote in 1894[3] "Lockyer's system of stellar classification provides for both an ascending and a descending branch of the temperature curve, and in this respect it certainly has advantages over other systems which claim to have a rational basis."

Prof. Frost[4] thus alludes to it: "Many spectroscopists are unwilling to admit that the only course of stellar development is along a line of descending temperature." He does not name the "many spectroscopists," but he adds: "The further question may be raised—Is it not possible that a celestial body, after it has reached the condition in which we may define it as a star, may twice be red and exhibit a spectra of the third type, once in its youth and again in its old age?"

In my papers are many statements giving the answer to this question, years before Prof. Frost put it.

In the Bakerian Lecture (1888) I published a temperature curve with ascending and descending arms, along which stars could be arranged according to their swarm- and condensing-conditions and their temperature as revealed by the spectra. On it were rearranged stars as classified by Vogel and stars with bright lines and nebulæ. Another curve was given in the catalogue of 470 of the brighter stars which I afterwards published in 1902, in which I classified stars only, giving to each group a distinctive name.

Of the stellar spectra used, some had been photographed at the Solar Physics Observatory and others by Mr. McClean at the Cape and Tunbridge Wells.

A few years after the publication of Vogel's memoir the work of classification was taken up at Harvard. The first one adopted was an alphabetical, from A and B onwards in one line. This we may mark as H.1.

At about the same time (1888) that I published my temperature curve at Kensington, the classification of northern stellar spectra in special new groups was being carried on at Harvard by Miss Maury as part of the Henry Draper Memorial. The classification was on one line of temperature in groups numbered from i to xxii. (H.2.).

But Miss Maury did not content herself with the group classification; over and above her twenty-two groups of spectra she gave us three main divisions of stars depending upon the characteristics of the individual lines. Here we find a physical touch superadded. In Division *a* were included lines narrow and clear, in *b* lines relatively wide and hazy, and in *c*, among other conditions, unusually intense metallic but not solar lines. I found these divisions of the utmost value to me when I was preparing my classification.

The Southern stars were undertaken by Miss

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[1] Phil. Trans., vol. clxiv., p. 292.
[2] Proc. R.S., vol. xliv., p. 1.
[3] "Ast. and Ast. Phys." 1894, p. 60.
[4] "Astronomical Spectroscopy," p. 318. 1894.

Cannon, who employed H.1., but some groups were discarded and stars between F and G, for instance, were classed as F5G or F8G. We may mark this as H.3.

The work of Harvard is monumental; tens of thousands of stars have been classified so far as small dispersion can do it, but obviously a straight line, instead of a curve of ascending and descending temperatures, has been followed in the three classifications used one after the other, and in all, if my views are sound, stars of vastly different constitution, sparse swarms and condensed stars, are called by the same name.

A subject of great regret is that, as this is the only large scale classification extant, it is now being used to deal with questions in which it is vital that stars differing in physical constitution shall *not* be classed together; in which such a mixing invalidates the conclusions arrived at in such inquiries.

In the last authoritative book published on these matters Prof. Eddington writes:—"From time to time there are indications that the Draper classification has not succeeded in separating the stars into really homogeneous groups. According to Sir Norman Lockyer there are stars of ascending temperature and of descending temperature in practically every group; so that, for example, the stars enumerated under K are a mixture of two classes, one in a very early, the other in a late stage of evolution."

Prof. Russell, a diligent worker on the characteristics and spectra of stars, has written as follows:—

"I have endeavoured . . . to set before you the present state of knowledge concerning the real brightness, masses, densities, temperatures and surface brightness of the stars, and to sketch the theory of stellar evolution to which the study of these things has led me. This theory is inconsistent with the generally accepted view. Its fundamental principle is identical with that of Lockyer's classification."

Prof. Russell objects to the principles on which I have placed stars in the different groups but that is another, and less important, story, which will be dealt with later.

Prof. Ludendorff[5] has recently provided a case in point; he has discussed Prof. Campbell's results on radial velocities and stellar types based upon the Harvard classification. Difficulties were met with. Dr. Ludendorff points out that these are avoided and that a distinct differentiation of the velocities is obtained if the stars are arranged in the order of ascending and descending temperatures. Of the sixty-three stars selected by Campbell, eighteen are contained in my classification; of these ten are on the ascending arm, and the velocities are all +; the remaining eight are on the descending arm, and the velocities, with one exception, are −. The exception is a star very near the top of the curve.

In arranging the programme of work for the Hill Observatory, the first place has been assigned to the continuation of the catalogue of the bright stars classified on my hypothesis (of two groups of stars, one increasing, the other decreasing their temperature), so that the 470 we already have may be as soon as possible increased to 1000, which will give us a broader base.

I have also occupied some time in considering stars varying from the normal condition dealt with in my published classification. These are:—

Stars with bright lines.
Variable stars with bright lines.
Variable stars without bright lines.
Double stars without bright lines.

The object of my inquiry was to ascertain whether further generalisations were suggested as regards the arm of the curve on which these stars should be most probably found, irrespective of their chemical constitution on which my classification was founded.

This further inquiry was based on my hypothesis[6] that the bright lines in variable stars were due to collisions between meteor swarms. Düner has shown that in Class III*a* (Antarian), of 297 stars 44 were variables, that is, 1 in 7. I found[7] in 1894 that in *β* Lyræ two bodies resembling Rigel and Bellatrix were involved. This lands us in the Crucian stage, nearly at the top of the ascending arm.

When we deal with variable stars without bright lines (eclipsing variables), the light curves show that we are dealing no longer with swarms, but with bodies with discs and therefore with photospheres, and therefore again approaching the solar condition. Now the best known variable of this class is Algol, the type star of one of my groups nearly at the top of the descending arm, nearly on a level with the Crucian group on the other.

From these facts we learn that bright line variables with the Harvard Classification, B. A. F. K. M. should be stars increasing their temperature, while eclipsing variables marked B. A. F. K. N. should be decreasing their temperature.

The result of the preliminary inquiries so far has been very encouraging.

Stars with bright lines have been found in species represented on the ascending arm of the curve, and none on the descending side.

All variable stars with bright lines so far studied belong to the ascending side, eclipsing stars which do not show bright lines to the descending arm.

A great majority of the double stars without bright lines so far considered belong to the descending arm.

Details on all these points will be given when the research is further advanced.

It may be remarked that the danger of using the Harvard classifications is not the same for all the groups.

The normal stars which differ most in their physical state are the Antarian (ascending) and the Piscian (descending). These are differentiated by the adjacent letters M and N (A and Z would have been better).

One of the finest memoirs which has ever been written on stellar spectra is that of Düner on the two types, III*a*. and III*b*. of Vogel's classification. And a study of it will show that no two groups of spectra differ more widely than these.

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[5] *Astronomische Nachrichten*, No. 4847, vol. cxc., p. 193.

[6] Proc. Roy. Soc., 1888, p. 80.

[7] Proc. Roy. Soc., vol. xli., p. 273.

To secure simplicity I represented the two arms of the temperature curve of equal inclination, and to save space I used a narrow angle between them (although by all analogy the descending arm should fall less rapidly than the ascending one). The more the curve is flattened the less difference there will be in the physical conditions of stars on either side of the apex representing the highest temperature. These stars, therefore, will be difficult to classify, and even some of the conditions may vary in the Alnitamian, Crucian, and Achernian groups.

It is half-way up the two curves that the greatest confusion may arise if stars of the same name; (A, F, K) are treated as if their physical state were similar, α Cygni and Sirius, for instance, both A in the Harvard classification (H.3).

NORMAN LOCKYER.

(*To be continued.*)

THE SERVICE OF SCIENCE.

A FEW months ago public attention was being directed by articles and letters in the *Morning Post* to the inadequate remuneration and prospects of scientific workers, particularly those engaged in research. The subject is one to which many columns of NATURE have been devoted since the foundation of this journal in 1869, but it cannot be too widely discussed if any serious effort is to be made to secure improved conditions in the future. The present is not perhaps the most propitious moment to ask for increased endowment of science and encouragement of discovery, but there are points relating to the position of science which can be stated as appropriately now as at any time. Some of these matters are referred to in an article on "Science and the State" in the October number of *Science Progress*, and the whole subject is under consideration by a committee of the British Science Guild.

The article in *Science Progress* is in continuation of one which was published in the April number, and its purpose is to offer a programme of steps toward the betterment of science in Britain and elsewhere. It is shown that the emoluments of scientific men are much below what might reasonably be expected for exceptional attainments; and the claim is made that the State should offer special rewards or pensions to investigators whose researches have proved of decided national or public advantage without being profitable to themselves.

The unsatisfactory positions of many professors and lecturers in our universities and other institutions of higher education, is due largely to the management of the institutions by commercial men who like to see fine buildings but are unable to understand the use of most of the work carried on in them. It comes as a surprise to such men to be told that in scientific circles usefulness is rarely adopted as the standard of value; and that even if not a single practical result is reached by an investigation, the work is worth doing if it enlarges knowledge or increases our outlook upon the universe. This proposition, of course, leaves the practical man cold; yet it is all that science desires to offer in justification of its activities. While the discovery of truth remains its single aim, science is free to pursue inquiries in whatever direction it pleases; but when it permits itself to be dominated by the spirit of productive application it will become merely the galley-slave of short-sighted commerce. Almost all the investigations upon which modern industry has been built would have been crushed at the outset if immediate practical value had determined what work should be undertaken. Science brings back new seeds from the regions it explores, and they seem to be nothing but trivial curiosities to the people who look for profit from research, yet from these seeds come the mighty trees under which civilised man has his tent, while from the fruit he gains comfort and riches.

Industrial research is concerned, not with the discovery of truth, but with the production of something which will be of direct service to man and from which pecuniary profit may be secured: it is the province of the inventor rather than that of the man of science. Such research and that carried on with no ulterior motive are complementary to one another. Science has done its part when it has made a new discovery; constructive engineering renders good service when it shows how the discovery may be chained to the advancing chariot of industry. To foresee the possibilities of a discovery, to transform a laboratory experiment into the mechanical plant of a large works, or to apply it to the needs of ordinary life, require aptitudes not commonly possessed by the scientific investigator. The engineer usually has such practical purposes in mind; discoveries are to him things to be used and not ends in themselves, as they are to the man of science. He seeks not so much to know Nature as to circumvent her; and the research which he undertakes or organises has for its object the artificial preparation of substances which are naturally rare, the production of a new process or the improvement of an old, the design of machines which will increase his power over her, and of instruments which will enable him to laugh at limitations of time and space.

Research is necessary for these advances, but the spirit in which it is carried on is essentially different from that of the scientific worker. The engineer or the inventor first of all perceives a need and then endeavours to devise a means of meeting it. If he is of a scientific type of mind he will make an accurate analysis of the conditions to be fulfilled, and then design his machine or instrument to fulfil them; but the usual way is to find practically what will perform the required functions, and to leave experience or scientific knowledge to indicate how improvements may be effected.

Scientific research may thus be divided conveniently into two classes—one in which the motive is solely the desire to extend the boundaries of knowledge, while in the other the special purpose is to obtain results which have a direct bearing upon problems of manufacture and construction. Explorers on the ship of science go out to discover new lands; and their spirit is not the same as that which actuates the prospectors who follow them with the intention of making the lands profitable to themselves and others. Both these classes of pioneers have their proper places in the scheme of progress, but they live in different atmospheres. The scientific investigator must have freedom to follow his own course wherever it may lead, whereas technical research can be organised and definite problems presented for which solutions of direct service to man are sought. The standard of value in one case is that of knowledge only, while in the other it is that of profit or use. The scientific mind desires to understand Nature; the engineering mind to control her for material purposes.

Some time ago the votes of the readers of an American periodical—*Popular Mechanics*—were taken as to what inventions were considered to be the "seven wonders of the modern world." From a list of numerous inventions, seven had to be selected; and those which received the highest number of votes were: wireless telegraphy, the telephone, the aeroplane, radium, antiseptics and antitoxins, spectrum analysis, and X-rays. Each one of these things had its foundations in purely scientific work, and was not the result of deliberate intention to make something of service to humanity.

It would be easy to give many further instances of the foundation of great industries upon results obtained in scientific investigation. Credit is, of course, due to the engineers who convert laboratory experiments into commercial undertakings, and to inventors for making use of scientific results in the production of instruments and devices for the convenience and comfort of man; but in both cases they are adapters of new knowledge rather than creators of it. The new field is opened by the man of science, but he is usually forgotten by those who afterwards take possession of it.

National well-being can only be secured when the close relation between it and scientific progress is understood. Discoveries which lead directly to developments of industry and manufacture may almost be left to take care of themselves, and the search for them is not likely to be neglected, but it is not the case with those for which no immediate use can be seen, yet almost all scientific research comes within that category. This is the kind of research which needs encouragement more than any other, and demands the greatest amount of originality, inspiration, and enthusiasm, to produce apparently insignificant results. The man who has zeal for work of this kind, who is a born researcher, should be cherished by his country above all others, and every advantage be offered him for the pursuit of knowledge.

When men of science ask for funds for scientific research they do not wish to bury the talents they receive or to derive personal profit from them. Whatever amount is entrusted to them is returned a hundredfold in the results achieved. How many are the researches worthy of assistance, and how small are the funds available for investigations having no obvious practical application, are understood only by men of science themselves. It would be a revelation to people endowed with a larger share of worldly riches to be present at a meeting of the committee of the British Association concerned with the allocation of grants for scientific purposes. Thirty or forty of the leading men of science in the British Isles discuss for several hours how to divide the sum of about 1000*l.* which represents the amount available from the sale of tickets at each annual meeting. There are many applications for grants from committees of each of the twelve sections of the Association, and the amount required has usually to be whittled down to 5*l.* or 10*l.*, which often does not cover the expense of stationery and postage of a research committee. Not one penny goes into the pockets of the men who are conducting the researches, yet claim after claim has to be passed, or reduced to its lowest limits, because the fund is miserably inadequate to meet the demands made upon it.

The Royal Society was unable to find the money required to print Newton's "Principia," and it was published at the expense of his friend Halley. Our scientific societies are in no better position to-day. Their members—most of whom possess but very slender means—pay by their own subscriptions for the publication of the results of their investigations. They sacrifice their leisure, and draw upon their limited resources, not only that knowledge may be increased, but also that the gain may be published to the world, which is free to make use of it.

It is difficult for the man of the world to understand the altruistic spirit which induces men of science to band themselves together in societies having for their sole aim the advancement of knowledge in particular directions; and that these men should themselves pay to enlighten and benefit others by the publication of their researches is almost incomprehensible to the selfish or money-making mind; yet such is the case. While the annual State grant made by Great Britain towards the expense of the publications of learned societies is limited to the sum of one thousand pounds to the Royal Society, several times that amount is provided each year for stationery alone used by members of the House of Commons.

The politicians who pay themselves a salary for the time they devote to party tactics and personal persiflage would be astounded if the proposal were made to provide for the support of Fellows of the Royal Society or of any other scientific institution, yet of the relative values to the nation of the work done in the two spheres of politics and science, there can be no question. In a splendid building and surrounded with all the appurtenances of precedent and dignity, months and years are wasted in a game of finding weak points in arguments relating to subjects many of which are of doubtful national importance; while the scientific elect of the country are crowded in modest apartments to discuss discoveries which it has cost them much time and frequently much money to complete, and for the publication of which they must themselves make provision. It requires the satire of a Swift to describe the disparity of support afforded to polemics and natural philosophy by a State that owes most of its modern advance to scientific work.

There is no doubt that the greatest contributions to knowledge have been made by men who undertook their inquiries into Nature without thought of proximate or ultimate practical application or pecuniary reward. It is true also that the best kind of scientific investigation cannot be carried on in an atmosphere of commercialism, or where personal profit is the end in view. This, however, does not relieve the nation of the responsibility for seeing that the rare aptitude for original research receives the most generous encouragement. At present a scientific career is the last into which a man should enter who expects a reasonable reward for his knowledge and industry; for it is the least lucrative of all professions. The reason is that its members do not form a corporate professional body to secure for science the position which it should hold in the thought and affairs of the State; therefore, administrators and officials generally pay little attention to its claims. Scientific men should see that fuller national recognition is given to their work, and the programme in *Science Progress* will show some of the directions in which they may well effect improvements, so that the world shall recognise "the great principle that of all forms of human effort, those efforts which result directly in discovery, whether in science or in art, are by far the most important efforts for humanity."

R. A. GREGORY.

EXPLORATIONS ON THE NORTH-EAST FRONTIER OF INDIA.

AMONGST the many activities of the Indian Survey Department not the least in scientific interest is the series of exploratory surveys which have been carried out on the north-east frontier, to the north and east of Assam, in the wild and mountainous hinterland which lies between Tibet and Burma. The scientific interest of these explorations is two-fold, geographical and ethnographical. The region dealt with in the report of Colonel Sir Sidney Burrard (Surveyor-General of India) embraces the principal basins of the rivers Mekong, Salween, and Irrawaddy and the Himalayan catchment areas of the four principal feeders of the Brahmaputra, namely, the Lohit (Zayul), the Dibang, the Diháng, and the Sabansiri, and for the sheer physical difficulties offered to systematic mapping is probably unmatched by any equal area in the world.

The scantiness of population, denseness of jungle, altitude of ranges, steep precipices, torrential streams and infernal climate have so far practically barred communication between India and China and between Tibet and Burma. It is here that four survey detachments have been working intermittently from 1911 to 1914 to assist each other in cracking that old geographical nut which lay enshrined in the mountains which overhang the course of the Brahmaputra and the sources of the Irrawaddy. We have heard of the remarkable exploits of geographers, such as Captain Bailey, who traversed those regions with unexampled success and vindicated the reputation of earlier native explorers, but we have not heard much of the determined efforts of the official pioneers of scientific mapping, whose work furnishes the basis of all successful explorations.

The scientific interest of work accomplished in the field of geography is naturally great and varied, for it is comprised in a large field of 28,000 square miles of hitherto unknown and unmapped mountains. Perhaps the chief point which calls for recognition is the discovery of a gigantic snow peak (Namcha Barwa), 25,445 ft. in altitude, far to the east of Kinchinjunga. The discovery of a peak in Assam nearly as high as Nanda Devi (25,645 ft.) "marks an epoch," says Col. Burrard, "in the history of Himalayan explorations," and the further fact that the Brahmaputra cuts its passage across the Himalayas at the base of this mountain gives rise to a curious problem in mountain hydrography; for it is noteworthy that the Sutlej, the Indus, and the great river of Hunza all cut through main ranges close to the points of supreme elevation of those ranges. Is this only a coincidence, or are we to seek for a reason in the processes of construction of mountain chains?

Another interesting matter is the absence of falls in the Brahmaputra. This is a feature common to most, if not all, of the great Himalayan rivers which descend rapidly from great altitudes to the plains. There are, indeed, magnificent cascades throughout the Himalayas, and a tremendous drop is not uncommon at the point where a tributary joins its parent river, but there are no falls in the main streams.

As for the ethnographical interest of the regions under review, it is so extensive and embraces such a variety of problems that it is only possible to point out generally that here, if anywhere, are we to find the modern representatives of the very oldest of primeval Asiatic races. We are content to generalise under such terms as Tibeto-Burman, or Indo-Chinese, a vast aggregation of tribespeople who differ so widely in their social idiosyncrasies, and even in anthropological features, that there must almost certainly be amongst them survivals who can help point the way to the very beginning of the human alphabet in Asia. All information that can be obtained about them, about their physical conditions, their habitat, their manners, methods and creeds, is of the greatest scientific value—all the greater that, as civilisation advances, opportunities for the careful study of these people will surely diminish. It is indeed the human interest in exploration which now specially calls for the attention of geographers, for such slight glimpses as we can get into the earliest stages of human existence are getting less and less. They are rapidly passing away, whilst the great wide spaces of unexplored world-surfaces where humanity is not, and never was, can well await the geographer of the future.

T. H. HOLDICH.

POTASSIUM SALTS AND AGRICULTURE.

ONE of the first results of the European War was to cut off the supply of potassium salts, which play a large part as fertilisers in modern agriculture. Our crops of potatoes and our supplies of milk are particularly dependent on abundant supplies of these particular fertilisers, and practically all the world's supply has hitherto come from the Stassfurt deposits in Germany.

The three crops that stand most in need of potassic fertilisers are potatoes, mangolds (used for dairy cows), and sugar beets. In addition, two types of soil need them for other crops: light sandy soils and peaty soils. Enormous amounts are required in Germany, where vast areas of these two types occur, and where sugar beets and potatoes are largely grown; in Sweden for the same reasons; in France and the United States for the production of sugar beets; and in this country for mangolds and potatoes. It is not surprising, then, that nearly ten million metric tons per annum are consumed.

Fortunately the conditions in British farming are such that potassic fertilisers are not indispensable, at any rate for two or three years. Potassium salts form insoluble combinations in the soil, and do not wash out; any excess not removed by the crop is therefore in safety. Further, a considerable proportion of what is absorbed by the crop finds its way back to the soil in farmyard manure, the materials sold off the farm not as a rule containing much potash. The supplies stored in the soil can be utilised to advantage by a suitable dressing of lime or chalk, which displaces the potassium from its insoluble combinations, and also by addition of sodium chloride, which has the same effect and in addition economises the consumption of potassium by the plant.

But there are sources still open to the farmer. Seaweed contains considerable quantities of potassium, which would become available on a proper reorganisation of the kelp industry on modern lines. The farm itself can also supply something. At this time of the year a good deal of hedge cleaning has to be done to make a clear way for the plough, while later on the hedges have to be cut back to keep them sufficiently low. The material is very bulky, and has to be burnt straight away; it yields an ash found at Rothamsted to contain about 10 per cent. of potash (K_2O), which is thus nearly as rich as kainit (12·5 per cent. K_2O). The hedges from each ten acres of land yield about 1 cwt. of ash, so that a 300 acre farm—quite a usual size for a holding—could provide itself with about 30 cwts. per annum if all could be collected. Unfortunately collection is a matter of some practical difficulty excepting in fine dry weather.

Taking all circumstances into consideration, however, it does not appear that British agriculture will suffer for two or three years from potash starvation, though when conditions become more normal the farmer will no doubt be glad enough to replenish the stocks in his manure shed and his soil. Up to the present it does not appear that any other of the common fertilisers will be cut off through the war. Indeed, the tendency is all the other way, and some of the supplies usually shipped to the Continent are now available for use in this country.

E. J. R.

NOTES.

THE anniversary dinner of the Royal Society, usually held on St. Andrew's Day, November 30, will not be held this year.

THE following have been elected officers of the Cambridge Philosophical Society for the ensuing session, 1914–15:—*President*: Prof. Newall. *Vice-Presidents*: Dr. Barnes, Prof. Seward, Dr. Shipley. *Treasurer*: Prof. Hobson. *Secretaries*: Mr. A. Wood, Mr. F. A. Potts, Mr. G. H. Hardy. *New Members of the Council*: Mr. J. A. Crowther, Mr. H. H. Brindley, Dr. Fenton, Mr. H. Hamshaw Thomas.

ACCORDING to the Christiania correspondent of the *Morning Post*, a monument in the form of a monolith 15 ft. high has just been completed at Christiania and is intended to commemorate the gallantry of the late Captain Scott and his companions in their Antarctic expedition. It has been subscribed for by Norwegian friends of the explorer. On the front are inscribed the names of Captain Scott and those who died with him, while at the back is a short record of the expedition.

A CASE is recorded in the daily papers of a soldier who, during a recent engagement, was shot in the forehead, the bullet passing out of the back of his head without killing or even stunning him. He remarked, "Everything seems green all round me." When in the hospital tent he still saw everything green, but otherwise made no complaint. This case appears to favour the cerebral theory of colour vision of Dr. Edridge-Green, the shock to the brain having altered the discriminatory apparatus so that impulses caused by green rays had a preponderating influence.

THE opening meeting of the one hundred and sixty-first session of the Royal Society of Arts will be held on Wednesday evening, November 18, when an address will be delivered by Sir Thomas H. Holdich, vice-president and chairman of the council. The following are among the arrangements for meetings before Christmas:—November 25, Sir William A. Tilden, "The Supply of Chemicals to Britain and her Dependencies; December 2, Dr. W. R. Ormandy, "Britain and Germany in Relation to the Chemical Trade"; December 9, Mr. W. A. Young, "Domestic Metal Work of the Eighteenth Century"; December 16, Sir William Abney, "Testing Pigments for Permanence of Colour"; December 17, Dr. F. Mollwo Perkin, "The Indian Indigo Industry."

WE notice with satisfaction that various scientific societies are welcoming Belgian refugees who are interested to attend their meetings. The Society of Engineers has opened the offices of the society at 17 Victoria Street, Westminster, daily from 10 a.m. to 4 p.m. (Saturdays, 10 a.m. to 1 p.m.), to Belgian engineers who are now in England on account of the war, and they are invited to apply to the secretary when they are in need of any information. Belgian engineers who are unable to call are invited to send their names and addresses to the secretary so that they may be in touch with their colleagues and receive invitations to the meetings. A committee of the Linnean Society has been empowered to invite Belgian botanists (whether ladies or gentlemen) to attend the meetings of the society and to make use of the library. The council of the London Natural History Society, too, invites any Belgian refugee interested in natural history to attend the meetings of the society and offers them the use of the society's library and collections. Particulars of the meetings, which are held at Hall 20, Salisbury House, London Wall, E.C., at 7 p.m. on the first and third Tuesdays of the month, can be obtained from the honorary secretary, Mr. J. Ross, 18 Queen's Grove Road, Chingford, N.E.

MR. H. W. CODRINGTON, of the Ceylon Civil Service, has compiled a useful catalogue of the collection of the European (exclusive of Roman) and Muhammadan coins in the Columbo Museum. The Indo-Portuguese and the Dutch coinage of the period 1640–1796 are well represented in the collection, and this catalogue, which is illustrated by a good series of process plates, will be of considerable interest to numismatists.

THE Journal of the Royal Society of Antiquaries of Ireland for September is largely occupied with a guide to the antiquities of Dublin and the neighbourhood provided for the use of the meeting which was held in June last. This publication is written by the most competent authorities, is well illustrated, largely from old engravings, and contains a fuller and more judicious account of the local antiquities than can elsewhere be procured. The description of St. Doulagh's Church, with its remarkable anchorite's cell, is specially to be commended.

IN *Man*, for November, Mr. J. Reid Moir discusses the question of the striation of flint surfaces in relation to the speculations of Dr. W. Allen Sturge, who attributes the markings on flints found in north-west Suffolk to at least six minor glaciations which occurred in Neolithic times, and he thus pushes back the advent of Neolithic man to a period about two hundred thousand years ago. Mr. Reid Moir, as the result of experiments on flint scratches, points out that this substance is far from being homogeneous, and that the belief in its hardness applies only to a freshly broken, unchanged sound flint. Exposure to the atmosphere produces patination or softening. It is thus impossible that flints long exposed to the weather could retain these scratchings for a lengthened period, and those found lying on the surface may owe their striation to ordinary causes, possibly connected with agricultural operations. The composition and character of flint are so important in connection with the age attributed to implements made of this material, that a more thorough examination of flint structure and its susceptibility to striation is an inquiry which should be systematically undertaken by a committee of competent geologists and archæologists.

IN the Journal of the Royal Society of Antiquaries of Ireland for September Mrs. Brunicardi contributes an interesting summary of our existing knowledge of the shore-dwellers of ancient Ireland. The map shows the curious distribution of their kitchen-middens. They appear at only three sites on the east coast, while on the west and south they are fairly numerous, chiefly in Donegal, Galway, Clare, Kerry, and near the harbours of Cork and Waterford. The writer discusses these remains in great detail with references to the original authorities. Very little pottery and no evidence of the use of metal are found in them, and Mr. Knowles regards them as among the earliest remains we possess of the Neolithic age. These shore-dwellers appear to have been a distinct race, probably a degraded one, living almost entirely on shell-fish, periodically migrating in search of food, but possessing what may be termed headquarters to which the whole tribe sometimes returned, and this they regarded as their home.

IN *Folk-Lore* for September Mrs. B. Z. Seligmann discusses the curious customs of demon possession and devil-dancing known in Egypt as the Zâr. After a full description of the rites, she arrives at the conclusion that they may have a double origin, from Abyssinia and the Sudan. The word Zâr is clearly Abyssinian, and must have been recognised in Egypt before the opening of the Sudan by Mahomed Ali and the consequent importation of black slaves. It must be remembered that the Red Sea route has been open for more than 2000 years, while intercourse with the Upper Nile has been intermittent, generally confined to raiding and plundering. This route, again, was barred by the Christian kingdom of Aloa, which up to the fifteenth century formed a barrier between Egypt and the Sudan. But whatever date may be assigned to the introduction of the Zâr into Egypt, there can be no doubt that its present popularity among the higher classes is due to the influence of black slaves received into the harems on a footing of perfect equality. Hence their cult of the dead was soon modified into a general belief in spirits which reinforced that which had perhaps already reached Egypt from Abyssinia. Mrs. Seligmann's graphic account of these rites may be usefully compared with that recently published by Major A. J. N. Tremearne, of Hausa customs of the same kind in his valuable work entitled "The Ban of the Bori."

WE have received from Mr. Edwards, of High-street, Marylebone, a catalogue of works relating mainly to fishes, fisheries, and angling.

Two excellent plates illustrate an article by Dr. Annandale in vol x., part 5, of Records of the Indian Museum on new and other stalked barnacles from Indian waters. Most of the species are of minute size; the most remarkable being one (*Heteralepas reticulata*) found in clusters on the spines of a sea-urchin. It is easily recognised by its "honey-pot" shape.

A MUCH compressed report, crowded with detail, by Mr. T. Southwell, on the fauna of the Ceylon pearl-banks, and a second on the food of certain marine Ceylonese fishes have been issued in the Educational Section (Science and Art) of the Ceylon Administration Reports for 1912–13. Portions, at least, of the notes are promised in another and fuller form, when it probably will be easier to grasp and assimilate their contents.

IN the October issue of *Naturen* Mr. O. J. Lie-Pettersen continues his illustrated account of the Norwegian tit-mice. The birds of Sarawak form the subject of an article in vol. ii., No. 5, of the Sarawak Museum Journal, by Mr. R. B. Williams, who has made coloured sketches of about one hundred species, from examples shot by himself. These sketches are accompanied by notes on the appearance of the freshly-killed birds and on the habits of the various species, and it is from these that the article has been compiled by Mr. J. C. Moulton.

ACCORDING to a notice in the November number of the *Museums Journal*, Dr. F. A. Lucas, director of the American Museum of Natural History, New York, disapproves, as a general rule, of large special exhibits in zoological museums, on the ground that when they are closed there is a marked falling off in the normal number of visitors. This, however, has not been the experience at the Natural History branch of the British Museum, as a result of the various special exhibitions which have been displayed at different times during the last few years; and even if it were the case, it would afford no argument for the abandonment of such temporary "side-shows."

IN addition to the gift of the type skull of the perissodactyle mammal *Pliolophus vulpiceps*, to which allusion has been made previously in our columns, Mrs. Richard Bull, widow of the late vicar of Harwich, has presented to the British Museum (Natural History) a skull and three shells of one or more of the three large species of marine turtles of the genus Lytoloma which occur in the London Clay of the Essex coast. The museum has also secured a specimen of the chelonian from the London Clay originally described by Owen as *Emys testudiniformis*, but now referred to the American fresh-water genus Chrysemys. It is in far better preservation than the type, and hitherto only known, specimen.

A GROUP of three East African buffaloes shot during the Roosevelt expedition was set up some time ago in the U.S. National Museum, amid an imitation of African scenery constructed of such material as was obtainable at Washington. This, however, was only a makeshift, and the museum has recently procured from East Africa a quantity of papyrus and reeds for the purpose of making a really vivid model of a buffalo-swamp. In the case of the papyrus the stems are slit open, the pithy interior removed and replaced by plaster, and the whole painted green. For the last few months the buffalo group has been withdrawn from public exhibition; but according to an announcement made by the Smithsonian Institution at the end of October, it was then shortly to be reinstated with its new surroundings complete.

THE October Bulletin of the American Geographical Society contains a preliminary report by Mr. R. S. Holway on the recent volcanic activity of Lassen Peak in northern California. The mountain, which rises at the southern end of the Cascade Range to a height of 10,437 ft., is an old volcanic cone from which a lava flow occurred some two centuries ago. On the north side of the bowl of the old crater, a series of steam explosions, beginning on May 30 last, has opened a new vent, from which stones have been thrown over an area more than half a mile in diameter. No freshly molten lava has been seen, and no heat has been noticeable except that of the escaping steam. Mr. Holway gives a list of twenty eruptions up to July 15. The formation of this new vent is the first recorded instance of volcanic activity witnessed in the United States, excluding the outlying regions.

WE have received from Japan the three parts of the Bulletin of the Imperial Earthquake Investigation Committee which were issued in the months of July, August, and September of the present year. The first two of these are devoted to a discussion by the able seismologist, Prof. Omori, of the eruptions and earthquakes of Asama-yama from 1911 to the date of issue. The records of the seismographs at the volcano-house of Yuno-taira and more distant localities are compared with the observations made in the crater of the volcano, the general conclusion arrived at being that the activity within this gigantic volcanic vent is now gradually subsiding. In the number issued in September, the same indefatigable observer gives a graphic account of his own studies of the Sakura-jima eruptions and earthquakes in January, 1914. The author was a member of the Commission sent by the Japanese Government to prepare a record of that eruption, which Prof. Omori thinks "may be counted, in point of the magnitude of disturbance, as one of the greatest volcanic catastrophes in modern times." An account of this outburst appeared in NATURE of January 22, 1914 (vol. xcii., p. 589). The bulletin is published in English, and the printing and illustrations reflect the greatest credit on the Japanese publishing office. More than fifty plates, including exquisite photographs with clear maps and diagrams, illustrate these three numbers, which constitute a very important contribution to the sciences of seismology and vulcanology.

The Bulletin of the Imperial Institute (vol. xii., No. 3) contains, in addition to reports on the results of the scientific and technical work of the staff on various colonial products, a special article on the agricultural resources of the Zanzibar Protectorate by Mr. F. C. McClellan, Director of Agriculture, Zanzibar, who describes the climate and system of land tenure in this portion of the Empire, discusses questions of labour and wages, and deals fully with crops and products, the chief of which are coconuts and cloves. In the latter article Zanzibar has practically a monopoly of production. In connection with the campaign for the capture of German trade an article on the trade in palm kernels is of importance as showing that a large proportion of the exports of palm kernels from West Africa are shipped to Germany, where they are used as the source of palm kernel oil and of cake for feeding live-stock, much of the palm kernel oil being re-shipped to this country. This important trade and industry could be well carried out in this country. Other articles deal with the utilisation of waste fish as a source of manure, the tin resources of Australia, South Africa, and Nigeria, and the trade of the Seychelles. Prof. W. R. Dunstan's address at the opening of the third International Congress of Tropical Agriculture (June, 1914) is printed *in extenso*.

The *Scientific American* for October 10 contains several features of particular current interest. In an editorial the view is put forward that in the event of conscription becoming universal, scientific men should be exempt. They are of incalculable value in the advancement of mankind, and as such their loss would entail greater sacrifices than could be compensated for by their use in the fighting field in which their efficiency and their numbers would probably be too small to have any appreciable influence. In a short note a method is given of hardening the concrete floors of factories. A mixture of 15 to 20 lb. of iron dust with 100 lb. of cement and twice that amount of sand is applied as a surface coating about an inch thick.

We learn from the Smithsonian Institution that Mr. T. W. Smillie, who has been photographer to the United States National Museum in Washington for the last forty-five years, has gathered together and arranged for the museum a collection of ancient and modern photographic apparatus and specimens. It is claimed that this collection is the most complete in the world. It includes what is believed to be the first American camera, namely, that made in 1839 according to Daguerre's specification, for Dr. S. F. B. Moore; also a print from one of Niepce's plates made in 1824, several fine Daguerreotypes dating from 1839 and onwards, specimens of Fox Talbot's earliest process, and his calotypes, and some early examples of "moving pictures."

Just as everyone should know something about the general rudiments of astronomy so a knowledge of the elements of our weather and climate should be universally understood in these isles. The earlier such knowledge is acquired the more natural is the interest taken in such figures and diagrams which appear in our daily papers. Besides, we all experience our "weather," and this should be sufficient to bring home to us the importance of understanding such data as are thus placed before us, and should make us wish to take an intelligent interest in some of the elementary principles. Under the title of "Weather Chart Exercises" (British Isles and West of Europe), compiled by Miss L. M. Odell, and published for the University of London Press by Messrs. Hodder and Stoughton (London), we have before us a series of exercises which have been given in connection with the explanation of the weather charts issued by the London Meteorological Office, and in the working out of climate with special reference to the British Isles. The exercises consist in drawing monthly curves of rainfall and temperature, drawing isotherms and isobars, differentiating between high- and low-pressure systems, and many other important factors regarding weather. All the data which are to be used are given in tables, printed forms and charts accompanying them so as to minimise the time spent by the pupil in unnecessary and mechanical work not really belonging to the subject. The exercises are arranged in a progressive order of difficulty and the treatment throughout is excellent and reflects great credit on the compiler. The fact that the new units (millibars), as well as the old, are employed, speaks well for the up-to-date character of the work. It may be suggested that as the map showing the "observation stations" and the "conversion tables" are so frequently to be used both of these should be printed on folding leaves at the end so as to be before the student on whatever page he or she may be working.

In the *Biochemical Journal* (vol. viii., No. 4, p. 438) Miss M. Cunningham and Dr. C. Dorée discuss the formation of ω-hydroxyfurfuraldehyde from various carbohydrates on distillation with hydrochloric acid under the conditions generally used in estimating pentoses by the well-known Tollens-Kröber method. The formation of this aldehyde is a source of error in estimating the pentoses, but it is shown that the condensation which produces the true furfural is almost completed before the hydroxymethyl derivative begins to distil over, and by using aniline acetate test paper it is possible to distinguish between the separation of the two aldehydes, so that little error is made in the estimation of pentoses or pentosans. Light is thrown in this paper on the so-called "furaloid" constituents of plants; in all probability these are merely hexose-yielding substances, which give hydroxymethyl aldehyde on distillation with acid, the latter substance being then largely decomposed by a second distillation with acid.

In *Science Progress* for October Dr. H. W. Bywaters gives an account, under the title "Vitamines," of recent work on nutrition, and of the light thrown by the researches of Funk, Hopkins, Osborne, and Mendel on the cause of such "deficiency diseases" as beri-beri, pellagra, scurvy, and rickets. These researches emphasise once again the importance of the part played by the "infinitely small" in vital changes, a part which has been more and more realised during recent years with the increased knowledge obtained of enzymes and similar agents. In a paper on the biochemistry of respiration, Dr. H. M. Vernon shows how recent research points in the main to its being dependent on intracellular enzymes—in some cases purely hydrolytic, in others partly hydrolytic, partly oxidative. Dr. R. W. Hegner deals with the germ-cell cycle in animals, Mr. A. G. Thacker has a paper on extinct apes, whilst Mr. W. L. Balls considers the question of the aid to be given by science in the future to the growing and utilisation of cotton. The theories of dyeing are discussed by Mr. E. A. Fisher, the problem of smoke abatement by Mr. J. B. C. Kershaw, whilst Mr. James Huneker has a short illustrated article on tornadoes and tall buildings.

THE geared turbine Atlantic liner *Transylvania* ran her trial trips a fortnight ago, and the observations of a representative of the *Engineer* who was present are of interest. There is some vibration in certain parts of the ship, but nothing to be compared with that which would be experienced with reciprocating engines. It was local, and of a very innocent description; it fact, it might be described as merely an absence of stillness. Owing to the high revolution speed of the turbines—1500 r.p.m.—the vibration speed is high. The noise in the engine-room is at present quite considerable, and is the typical roar of high-speed gearing. It is not easy to see how the noise may be eliminated entirely, in spite of the beautiful machines invented for cutting the gears. On the third-class passenger deck, gear noise disappeared totally at a distance of about 150 ft. from the engine-room entrance. On the deck above this, the noise disappeared at about 90 ft. from the companion-way. In fact, in the space used for passengers, the noise is just noticeable while listening carefully for it, and hence cannot be considered objectionable from the passengers' point of view, especially as the sound is not high-pitched.

THE Carnegie Institution of Washington has issued the first part—A to H—of the "Index to United States Documents relating to Foreign Affairs, 1828–61," which is to be completed in three parts. The index is the work of Miss Adelaide R. Hasse, the head of the department of documents in the New York Public Library, and an idea of the magnitude of her task can be formed from the fact that the present instalment of the index runs to 793 large pages. In addition to the reports of Congress, the following series of documents have been indexed: the Senate Executive Journal, for diplomatic and consular appointments and treaty ratifications; the Opinions of the Attorneys-General, for decisions on questions of international controversy; the Statutes-at-Large, for acts and resolutions relating to international affairs; and the Congressional Globe and its predecessors for speeches and correspondence.

OUR ASTRONOMICAL COLUMN.

COLOURS OF STARS IN THE CLUSTER M13 (HERCULES).—When stars are too faint to be spectroscopically examined, some idea of the type of spectrum involved can be gathered from their visually observed colour. It may happen that the stars are even so faint when seen in a powerful telescope that they exhibit no colour at all; it is then that the photographic plate is called in, the sensitive film being a great differentiator of colour. In the case of star clusters the opportunity is afforded of comparing a great number of stars, and it is of extreme value to know whether the stars involved are all of one physical condition or same spectral type, or whether they show representatives of all types. Especially is this the case when it is remembered that star clusters are most remote and must therefore be of immense magnitude. The photographic determination of the colours of some of the stars in the cluster M13 in Hercules is therefore of great value in this connection, and the research which we owe to Prof. Barnard (*Astrophysical Journal*, vol. xl., No. 2, September) is one that will be read with interest. In this paper the stars are practically divided into two colour classes, namely, blue stars and yellow stars, and this has been done by comparing two photographs of the same cluster taken under two conditions. One photograph was secured with the 13-in. astrographic refractor of the Potsdam Observatory, and the other with the 40-in. refractor of the Yerkes Observatory. The optical conditions on the Potsdam photograph were such that the blue stars were relatively brighter than the yellow stars, while on the Yerkes plate the reverse was the case. A comparison of the plates thus afforded a means of separating these coloured stars, but care had to be taken to eliminate all comparisons of star images where variability might be involved. Prof. Barnard concludes that in this cluster there exist stars of extremely different types, and hence, by inference, that there are stars of all the different spectral types. The paper is accompanied by reproductions of the Yerkes and Potsdam plates and an index chart.

THE ELECTRIC ARC AND SPECTRAL LINE DISPLACEMENTS.—Numerous references have been given in this column to investigations on the causes in terrestrial spectra of displacements of lines from their normal positions. In fact, the inquiry which was started some years ago to select and adopt certain standards of wave-length of iron, etc., show that little was known about the behaviour of lines under different conditions of electric current, arc length, etc. All attempts therefore to arrive at a final selection of lines suitable as standards are of fundamental importance to spectroscopists and astro-physicists, and in this report the communication by Mr. T. Royds (Kodaikanal Observatory, Bulletin xl.) on an investigation of the displacement of unsymmetrical lines under different conditions of the electric arc will be welcomed. To find a light source giving normal wave-lengths for all classes of lines is therefore an inquiry of the first order, and the present paper is an advance in that direction. The results of the present work are summed up in a series of brief paragraphs at the end of the paper, and while only a few of these can be referred to here, the reader should consult the original bulletin. When the spectrum of the region of the arc near the negative pole is compared with that of the centre, the unsymmetrical lines are displaced in the direction of their greater widening; symmetrical lines have very small or no displacements. The displacement near the positive pole is about half that at the negative. A displacement of the same sense as that at the poles is produced at the centre of the arc by increasing the current or shortening the arc. The displacement at the negative pole is reduced if only the positive pole is supplied with the material producing the spectrum. Displacements occur in the arc *in vacuo*, but to a much smaller extent than in air, and he suggests that the arc *in vacuo* is a better source for the determinations of standards of wave-length and for comparisons with the sun's spectrum.

ANNALS OF THE ZÔ-SÈ ASTRONOMICAL OBSERVATORY.—The seventh volume of the Annals of the Zô-sè Observatory is divided into four parts, and deals with solar, double-star and cometary observations made during the year 1911, together with a discussion of some early star observations made about the year 1744. The observations of the sun are confined to spots, faculæ, and prominences, and, in addition to the observations themselves, a very complete summary is given of their distribution in both latitude and longitude, with reproductions from the drawings of the chief prominences observed. Part ii. deals with the observations, both visual and photographic, of the double and multiple stars; while the third part is devoted to the observations of comet Brooks (1911*c*) and comet Borrelly (1911*e*). In the last-mentioned part comparisons are made with the observations of others who studied these comets, and an interesting series of reproductions from photographs of comet Brooks accompany the text. The last and fourth portion is devoted to a description and reduction of a catalogue of stars observed at Pekin under the Emperor K'ien-Long in the year 1744. Two reproductions of the old Chinese charts are given, and the stars have been identified and their positions reduced to the epoch of 1875, with accompanying charts. Historically interesting are the translations of the early decrees relating to the staff of the observatory and of the preface to the catalogue.

THE DEVELOPMENT OF CHEMICAL INDUSTRIES IN THE BRITISH ISLES.

UNDER the title of "The Capture of Germany's Chemical Industries," the *Chemical News* has published (vol. cx., p. 151) an editorial article dealing with the situation opened to English chemical manufacturers by the war, a situation which has already formed the subject of an article in NATURE (September 17, No. 2342). "A unique opportunity," it is stated, "is now offered of developing industries hitherto swamped by foreign competition, and the nation relies upon the enterprise of its scientific men to attack the subject with promptitude and vigour. It is satisfactory to find that the Government has already taken the matter up, and a Committee has been appointed to consider and advise as to the best means of obtaining for the use of British industry sufficient supplies of chemical products, colours, and dyestuffs of kinds hitherto largely imported from a country with which we are at present at war."

The same subject forms the text of an important article in the *Chemical World* for October, which, after reviewing the conditions which led to Germany's occupying a practically unassailable position in this field before the war, issues a note of warning as to the methods which must be adopted if England is to gain success in the future under greatly modified conditions.

"The combination of banking facilities, system of factory management, and scientific thoroughness in detail was undoubtedly one which our manufacturers found especially formidable." If the products which Germany has made, however, are to be manufactured under English trade conditions, "not during the reign of panic but as a permanent venture, it will need a strong pull and a pull altogether by the interests which are the equivalent of those enumerated above, be they what they may. A good deal of loose talk about the effect of the patent law has been beside the mark, when it is remembered that the only protection accorded to Germany in this respect was that given to the one who got to the Patent Office first. The race was to the strong; to the one best organised. It would be idle to fight such conditions, which represent modern scientific warfare at its best, with the tools of the 1870's."

A close inspection will confirm the statement made by a director of one of the largest German aniline dye manufactories, that not 10 per cent. of their products or output was protected by patent rights but by organisation along German lines. "Equally vague has been the statement that want of free alcohol has been at the root of England's failure. With alcohol at the cost of rain-water and free trade in the patents of other countries, the result would have been much the same in the absence of that spirit of scientific and deliberate correctness and efficiency and the peculiar self-effacement of scientific workers who, directing operations in the works at practically the wages of superior workmen, have achieved such results in the worldwide endeavour on the part of Germany to outclass all other nations in this special branch of industry."

There is no doubt that in the past there has been a very great neglect by many manufacturers of the services of the properly trained chemist. The writer recalls one case of a large English chemical firm, which had been the pioneer in elaborating the processes of manufacture of a certain widely used acid; after the death of the chemist who had initiated the processes which had brought this firm a golden revenue, operations were carried on for nearly twenty years, without a single trained chemist being employed in the factory to supervise or control the processes or introduce improvements, although the processes were of a complicated character, and the output represented a value of more than 150,000*l.* per annum. By this time Continental competition had become so severe that it was almost hopeless to regain ground which had been steadily lost year by year in this particular field.

There is little doubt that the value of employing numerous chemists in chemical works is becoming more and more appreciated in this country. The supply of well-trained chemical workers which is available for the coming struggle will be the most important factor in its decision.

AUSTRALIAN WELLS.[1]

THE great Australian artesian basin is, says this report, "undoubtedly the largest artesian area in the world, but at the same time there has probably been less work done on it than on any other artesian basin known" (p. xi.). There are two conflicting explanations of the nature of this basin. According to the older official view it is artesian, using that term in its original sense for a synclinal in which water enters at a high-level intake, spreads through a permeable layer under a wide cover of impermeable beds, and is forced up through wells by water pressure from the higher parts of the water-bearing layer. The intake beds beside this Australian basin were considered to be so extensive, so porous, and so well supplied by rain and streams that there need be no fear of the supply being appreciably reduced by artificial wells.

According to one calculation the wells put down in Queensland up to 1901 used only 1/183 of the annual supply from the rain, and other estimates have calculated that the supply, without any renewal, would last for 3000 years. According to a second hypothesis, the U-tube conception of these wells is inconsistent with the variations in the head of the water and in its chemical composition, and also with its high temperatures. According to this explanation the bulk of the water is water of cisternage, supplemented to a minor extent locally by rainfall; and the water is ejected, when the water-bearing layers are reached by bores, in consequence of gas pressure due to the introduction of hot plutonic water and to rock pressure due to the weight of the overlying shales on the water-bearing sands and sandstones. The question is practically important, for the policy to be followed in the administration of these well waters depends upon which explanation is adopted. The advocates of the first theory insisted that there was no evidence of any reduction on the yield of the wells and that no diminution need be feared. Some of the advocates of the alternative theory insisted that there would be a serious fall in the discharge.

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[1] "Report of the Interstate Conference on Artesian Water." Sydney, 1913, xv., 207. Pp. 68+40 maps and plates.

The problems connected with the supply have been referred to an Inter-State Commission, which has collected much valuable evidence and an atlas of most useful maps and plates. It considered, amongst other questions, the corrosion of the tubes used for lining the wells, which in some localities rapidly decay; the irregular distribution of this corrosion illustrates the great local variations in the nature of the bore waters. Prof. Fawsitt, who gave evidence before the Commission, attributes the corrosion to the action of carbon dioxide in the presence of free oxygen.

One of the most striking maps presented to the Commission is that showing the widespread diminution from the Queensland wells; many have ceased to flow and others are greatly reduced in volume. At first the advocates of the water-pressure theory attributed such cases to the choking of the bore or to the escape of water around the bore tubes; but the Commission rejects these explanations. The distribution of the dwindling supplies in Queensland shows that the cause is very widespread, and is subject to local variations which it is difficult to explain except upon the gas-and-rock-pressure hypothesis. The Commission has adopted the water-pressure theory, but it makes two great concessions towards the later theory. Its report remarks that "the gas in these waters must undoubtedly to some extent assist in bringing the water to the surface." The Commissioners add that the rise of the water is primarily due to hydraulic pressure; but as they recognise that gas pressure assists, the old calculations as to the water levels which have been represented as the strongest argument in favour of the water-pressure theory can no longer carry much weight. The Commission has also adopted a definition of artesian water which abandons the basis of the older hypothesis.

"*Artesian and Sub-Artesian Water.*—Water struck in bores may be under ordinary atmospheric pressure, or it may be under a pressure exceeding that of the atmosphere. In the former case the water may be termed ordinary ground water; and in the latter case the water may be termed either artesian or sub-artesian. Artesian water is subject to a natural pressure sufficient to force it above the surface of the ground" (p. ix.). According to this definition all water which rises to the surface of the ground, whether through any limestone source or boiling volcanic spring, is artesian—an *extensio ad absurdum* of the term.

IONISATION.[1]

IONISATION is the process by which ions—particles charged with electricity—are produced in a solid, liquid or gas. This address is confined to the consideration of ions in gases and deals with two questions: (1) the nature of the ions, (2) the process by which they are produced. The evidence as to the nature of ions is derived from experiments on their mobility which have shown:—

α. The mobility of a positive ion depends only on the gas through which the ions are moving and not on the nature of the gas out of which the ions are formed.

β. The mobility of the ions in a gas at constant density is independent of the temperature.

γ. There is a considerable number of gases in which the mobility is very approximately inversely proportional to the square root of the density of the gas.

δ. In the case of negative ions there is an abnormal increase of mobility when the pressure is reduced below a certain value, and there is some evidence that this is also the case for positive ions at very low pressures.

Two theories of the mobilities of ions were considered, one founded on the view that the action between ions and molecules is analogous to impacts between hard elastic spheres, the other on Maxwell's theory of forces between ions and molecules varying inversely as the fifth power of the distance between them.

It is shown that (α) follows from the second theory provided the ion is a cluster of which the mass is considerably greater than that of a molecule of the gas through which it is moving. On this supposition it follows also from the first theory if we suppose in addition that all ions in a given gas are of the same size.

(β) follows at once from the second theory; to explain it on the first theory we must suppose that the size of the ion varies with the temperature in a definite way. The necessary relation can be deduced from thermodynamical principles if we suppose that the force between an ion and a molecule is analogous to that between a charged point and a sphere which is either a conductor of electricity or has a high specific inductive capacity.

(γ) requires on theory one that the ions in these gases should be of the same size, on theory two that the molecules of these gases should exert the same force on a charged point at a given distance.

(δ) follows on either theory if the ion dissociates at low pressures so that free corpuscles are present in the gas.

With regard to the process of ionisation, the first stage of this in the vast majority of cases consists in the detachment of an electron or corpuscle. Evidence as to the method by which this takes place is afforded by determinations of the velocity with which the electrons are ejected from the body.

In the case of ionisation by light or Röntgen rays, this velocity depends primarily on the wave-length of the radiation, not upon its intensity, nor, at any rate to any great extent, on the nature of the molecule from which the corpuscle is ejected. This velocity is far greater, even when every allowance is made for resonance, than can be accounted for if we suppose that the energy of the light is uniformly distributed, and that the corpuscle acquires its velocity by the action on it of the electric force in the wave. Another explanation not open to these objections was put forward.

When ionisation is due to the action of moving electrified particles, whether positive or negative, the results are quite different. The velocity of the ejected particles (δ-rays, as they are sometimes called) does not seem to vary much, if at all, with the velocity of the particles which eject them, and is of the same order whether these particles are positive rays or the much swifter kathode rays. The method of ejection by the impact of such particles was considered, and suggestions as to a possible theory and some of its consequences thrown out.

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[1] Abstract of the presidential address delivered before the Physical Society on October 23 by Sir J. J. Thomson, O.M., F.R.S.

DENTAL MUTILATIONS IN NEOLITHIC HUMAN REMAINS.

MR. J. W. JACKSON, of the Manchester Museum, has reprinted from the *Journal of Anatomy and Physiology* (vol. xlix.) an interesting paper on dental mutilations in Neolithic human remains. These were first brought to light in the case of the celebrated Galley Hill skeleton, and further examples have now been discovered at the cave known as Dog Holes, on Warton Crag, Lancashire. In these latter examples the lower jaw was remarkable for the absence of the second premolar teeth on each side, and for the obliteration of all traces of the alveoli.

It is well known that during the rites of tribal initiation among the natives of Australia, the Ashantis, the Masai, and Sudanese tribes, and others, some of the lower teeth are removed. Prof. Elliot Smith has described a similar case in Ptolemaic-Roman burials in Nubia, and it prevailed in early Egypt. The occurrence of similar examples in British Neolithic interments is thus of considerable interest. Mr. Jackson is inclined to regard the practice in Britain as genetically related to similar customs elsewhere, particularly in eastern Africa, and he assumes that its occurrence among the early Egyptians some 3400 years B.C. represents a date only slightly earlier than that of the Neolithic age in Britain. It seems evident, he urges, that these early Neolithic people had retained some remnant of a rite or custom, formerly in use among themselves, or adopted from neighbouring tribes during their migration from their early home in the East.

Further, Mr. Jackson thinks we may assume from the presence of mutilations in so few of the jaws of what may be regarded as one clan or family group that, as in the case of some Australian aborigines, the significance of the operation might likewise have been lost, and that the practice became degraded into a merely optional custom through the isolation of the tribes in their northward migration, or through some advance in civilisation. In any case, the investigation may result in establishing a cultural chain linking the British Neolithic tribes with the pre-Dynastic Egyptians, by way of the Iberian Peninsula and northern Africa.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE Australian meeting of the association was remarkable for the extended nature and great interest of the excursions which had been arranged by the various local committees.

An advance party arrived in Western Australia on July 22, and were conducted by Prof. Woolnough, of the University of Western Australia, to the Irwin River, two hundred miles north of Perth, where sections were examined showing Permo-Carboniferous beds unconformably overlain by Jurassic rocks. The Permo-Carboniferous series includes near its base a bed of Conglomerate, the Lyons Conglomerate, which is shown by its numerous striated pebbles to be of glacial origin. The Lyons Conglomerate has been proved to extend for a distance of two hundred miles and is believed to be contemporaneous with similar beds in other parts of Australia and in South Africa, South America, and India.

On returning to Perth sections of pre-Cambrian slates at Armadale Brick Pits, and of crush-conglomerates of similar age at Helena River were examined, and on July 28, several additional members having joined the party, a start was made for the Stirling Ranges, 250 miles to the south, where highly contorted quartzites of unknown age were seen. Again turning northwards, the Archæan gneisses of the Toodyay railway section, which are covered unconformably by quartzite, probably of Huronian age, were visited, and, finally, an examination was made of the Coolgardie and Kalgoorlie area, both the underground workings and the surface plants receiving attention. On August 4 the party sailed from Fremantle for Adelaide.

From Adelaide a number of chemists and geologists visited Port Pirie, where the smelting works of the Broken Hill Proprietary Company were inspected, and whence a trip was made across Spencer's Gulf to the iron ore deposits at Iron Knob, whence the ore is now sent to the company's new ironworks at Newcastle, New South Wales. The party then proceeded to Broken Hill by special train, and spent a day in the examination of the underground and surface exposures of the famous lead-silver vein.

Another party visited the Cambrian glacial beds of the Sturt River and the Permo-Carboniferous tillites of Hallett's Cove, passing thence over the Upper Cambrian limestones, with Archæocyathus, of Sellick's Hill to the Inman Valley, where the striated surfaces underlying the Permo-Carboniferous tillites were first described by Stirling, and returned to Adelaide by way of the Mount Lofty Ranges.

At Melbourne, which was reached on August 13, the first meeting of the section was opened with an address by Prof. E. W. Skeats on the geology of Victoria, in which the general structure of the colony was described, particular attention being devoted to the areas covered by the official excursions. There followed a paper by Dr. T. S. Hall on Victorian graptolites, after which Prof. Johannes Walther exhibited and described a series of lantern slides in colour illustrating rock-disintegration by change of temperature and other phases of denudation characteristic of arid regions.

Prof. A. P. Coleman dealt with the climatic conditions of the Early pre-Cambrian. He referred to the desert conditions which are believed to have occurred during the Keweenawan or Torridonian period, and to the Ice age of the Huronian, and announced that recent work in Canada showed the action of water and a cool climate on the Sudbury series of pre-Laurentian age, and even in the still older Grenville and Keewatin series. "These are the earliest known formations, so that air and water worked in the usual way at the beginning of recorded geological time." Prof. Skeats read a paper on the Tertiary alkali rocks of Victoria, and Dr. H. S. Summers dealt with the origin and relationship of the same.

The morning of August 18 was devoted to a joint discussion with members of Section E on the physiography of arid lands, which was opened by Sir Thomas H. Holland, and continued by Sir Charles Lucas, Prof. W. M. Davis, Prof. J. W. Gregory, Prof. Albrecht Penck, Dr. Griffith Taylor, Mr. E. C. Andrews, Mr. A. L. Du Toit, Mr. Kenyon, Dr. W. F. Hume, Mr. H. T. Ferrar, Mr. D. M. S. Watson, and others.

The final day of the Melbourne meeting was devoted to the Tertiary deposits of south-eastern Australia. Papers on this subject were contributed by Mr. F. Chapman, Dr. T. S. Hall, Dr. G. B. Pritchard, Mr. R. Bullen Newton, Prof. J. W. Gregory, Mr. D. J. Mahony, and Mr. H. Herman, and were followed by a general discussion on the age and sequence of the strata.

The excursions during the Melbourne meeting included one to the area round Mount Macedon, where several exposures of alkali rocks, including anorthoclase trachyte, dacite, grano-diorite, and solvsbergite, were examined, and another to the celebrated Bacchus Marsh district, where the chief points of interest were the Tertiary basaltic lava flows, the magnificent gorge of the Werribee River and the Permo-Carboniferous tillites which may be seen resting on grooved and striated surfaces of slate, sandstone, and quartzite of Ordovician age, the surfaces in some instances being as fresh as those of Pleistocene age in Britain.

Sydney was reached by rail on August 20, and here the sectional proceedings were opened by Sir Thomas H. Holland's presidential address, which will be found printed *in extenso* in NATURE of September 3, and was followed by an address on the geology of New South Wales, by Mr. E. F. Pittman. Other papers read during the Sydney session included Prof. T. W. Edgeworth David and Mr. W. S. Dunn on the Permo-Carboniferous fauna; Mr. E. C. Andrews, "The Post-Jurassic Geography of Australia"; papers on artesian water by Mr. E. F. Pittman and Mr. S. Dunstan; on metallogenetic provinces of Eastern Australia, by Mr. C. A. Sussmilch; on the genesis of the diamond in New South Wales, by Mr. L. A. Cotton; on spilitic lavas in New South Wales, by Mr. W. N. Benson; and on structural features of the coal-fields of Pennsylvania, by Prof. E. S. Moore.

The geological excursions from Sydney were (*a*) to the Blue Mountains and Jenolan Caves, and (*b*) to West Maitland and Newcastle. The Blue Mountains are capped by the sandstones of the Hawkesbury series (Trias), which rests on Permo-Carboniferous and Carboniferous rocks, which are exposed in many of the valleys, and in turn rest with marked unconformity on the Upper Devonian of Mount Lambie. The Jenolan Caves, which are excavated in limestones of Silurian age, are well known for their magnificent stalactites.

The Maitland district is chiefly of interest on account of its workable coals, and the occurrence of beds of tillite and other glacial beds in its Permo-Carboniferous series.

The section of the Permo-Carboniferous system is the most complete yet described in any part of Australia. The highest beds are those of the Newcastle series, which are of fresh-water origin, and contain some thirteen seams with a thickness of 3 ft. and upwards. These rest upon the Dempsey series, with Glossopteris and Gangamopteris, which in turn overlies the Middle or Tomago Coal Measures with several important seams.

The Upper Marine series which underlies the Tomago consists of cherts, shales, and calcareous sandstones, and rests upon the Greta Coal Measures, which contain two principal seams, the upper varying from 14 ft. to 32 ft. and the lower from 3 ft. to 11 ft. in thickness. Below the Greta Measures lies the Lower Marine series.

The glaciation appears to have taken place from a radiant point situated in a now submerged region between Tasmania and Kangaroo Island, south of Adelaide.

The members who went to Brisbane divided into several parties, some visiting the striking trachytic necks of the Glass House Mountains, while others investigated the geological structure and gold-mining industries of Gympie and Mount Morgan. The Trias-Jura coal-bearing beds of Ipswich, near Brisbane, were also visited. The beds are considerably folded and rather heavily faulted, and rest unconformably on the Gneissose rocks of Brisbane.

Excursions which had been arranged to New Zealand and Tasmania were abandoned on account of the war in Europe.

A. R. D.

EDUCATION AT THE BRITISH ASSOCIATION.

THE section met in Melbourne and Sydney. The programme had been carefully divided between the two cities, but as it was impracticable to divide the presidential address, the organising committee arranged to give special prominence to the address of Prof. Armstrong (vice-president), which was to be given in Melbourne. It was a strong plea for the further recognition of science in education and in the State, and extracts from it have already been published in NATURE (October 22, p. 213).

Following upon Prof. Armstrong's address Mr. C. A. Buckmaster read a paper on State aid to science. It was an interesting retrospect of official experience which it is scarcely possible to summarise here, though we may express the hope that the paper will shortly be published in full. Mr. W. D. Eggar discussed the position of mathematics and sciences in a liberal education. In his view the "mathematics required by university qualifying examinations is either too little or too much." From the point of view of use, it is only men in scientific professions who require more than plain arithmetic, and simultaneous quadratics is insufficient to produce æsthetic appreciation of the subject in the educated man. Instead of Euclid, which appealed to clever sixth-form boys, we have now a hotch-potch in which any proof of a theorem is accepted if it is good enough for an engineer. In science, again, everything is sacrificed to the stupid boy. Only the science which is useful is favoured. Astronomy, for example, is not usually taught at school. The problem of education after all is the opening of windows of the mind, and in the teaching of any subject we should concern ourselves with the question, How far must we go to come to a window? Cannot some agreement be arrived at as to the number and position of the windows which should be opened by a liberal education?

The second day at Melbourne was devoted to the subject of vocational education. Dr. C. W. Kimmins gave an account of the London trade schools, which are designed to bridge over the gap between fourteen and seventeen. In order to make them accessible to poor children, maintenance grants rising from 6*l.* to 15*l.* a year, and free education, are liberally provided by the County Council scholarship scheme. Definite trade instruction is also given in certain instances (tailoring and bakery), but scholarships are not awarded in these cases. The trade school has also become a necessity owing to the decay of the apprenticeship system, in comparison with which it has certain compensating advantages—it provides better supervision, it does not neglect literary subjects, it takes a completer view of the trade itself, and it provides a due balance of theory and practice. These schools have the further advantage that they are governed by a consultative committee of experts—a most important essential in their success. The cost of such schools in London works out at 15*l.* to 21*l.* a year for boys, and 15*l.* for girls. Dr. Moody described his experiences in the organisation of commercial education, and Dr. Findlay dealt with the compulsory education of youth. A new type of institution and a new type of teacher are essential. Youth needs social experience and vocational guidance as well as instruction. Little can be done until the State accepts the principle of partial control over wage-earning youth. Mr. A. D. Hall considered that all education should be vocational: only then shall we get a product fit for something, because it has been subjected to the discipline of purposeful work. He outlined a scheme of agricultural education, which was a good deal criticised by Australian members as quite unsuited to their conditions. Mr. Frank Tate described the effort made in Victoria to redeem education from the charge of being too academic.

On the third day, the section discussed the training of teachers, in which Dr. Smyth, of the Melbourne Training College, Prof. Findlay, and Prof. Green took part. Papers were also read by Prof. Boyce Gibson on moral education; Mrs. Meredith, on domestic training in primary schools; and Miss Lilian Clarke, on the teaching of botany. All these papers aroused a good deal of interest, and excellent discussions followed.

Prof. Perry opened the Sydney meetings with his presidential address, which was published in full in NATURE of October 1. After the presidential address, the greatest local interest was roused by Prof. Netschajeff's paper on experimental pedagogics in Russia. It was chiefly devoted to a descriptive account of research work in the experimental school which he has founded in Petrograd under the auspices of the Ministry of Commerce. The work there is mainly directed to the investigation of the changes in the mental life of children as depending upon age, sex, and environment, as well as the determination of the best methods of teaching the various school subjects. The teachers' judgments upon individual children have also been the subject of psychological investigation. Work of this kind necessitates a threefold process. It begins in the laboratory itself, and passes thence to the school, coming finally to the laboratory again for discussion and further research. The body of workers attached to the school have also been engaged in simplifying and cheapening psychological apparatus. They have produced a cabinet of essentials at so reasonable a price that no fewer than 131 schools and teachers' societies in Russia have been supplied. Prof. Netschajeff presented a specimen collection of this apparatus to the education department of the University of Sydney.

Another day was devoted to the discussion of the problem of the university in its relation to State and school. Sir Harry Reichel made a strong plea for university freedom. The whole work and spirit of a university would be killed by anything like bureaucratic control. Mr. Board, Secretary for Education in the State of New South Wales, gave general support to this view. Prof. Green urged the need for greater freedom for the schools, which at present suffer from the relatively rigid requirements of university entrance. Intellectual keenness is commonly lost in the effort to meet the demands of matriculation examinations. Schools also have yet to learn that their function is not defined by the university but by the needs of the vast majority of their pupils who do not intend to enter the university at all. Dr. H. B. Gray read a paper on school training for public life, in which he pleaded for a more liberal treatment of science in the public school. Thus he would not give more than from one-quarter to one-sixth of school life to the classics. More geography, a thorough study of one modern language, and of English literature and history would then be possible, and science might get reasonable treatment. Socially, too, the public schools need reform. They suffer from narrowness of outlook, which may serve to produce rulers of inferior races but does not turn out men suited to play a great part in the newer democracies.

Prof. Mackie read a paper on the training of teachers, giving an account of the conditions in New South Wales. A discussion followed in which Prof. Findlay, Dr. Kimmins, and Prof. Green took part. All the speakers emphasised the need for greater attention being given to research and experiment in this sphere of practical work. Dr. Kimmins gave an interesting account of a London County Council scheme for an Imperial interchange of teachers—a plan which would enable Australian teachers to spend a year at home, at little cost to themselves, and with the great advantage of enabling them to learn something of their profession as practised in London.

The sectional meetings were uniformly well attended, though along with other sections it suffered considerably at the hands of the Press on account of the war. Many English visitors enjoyed the opportunity of visiting educational institutions in the various States. All were impressed by what they saw. Everywhere, and particularly in New South Wales and Victoria, we found evidence of a profound belief in education and a readiness to make sacrifices in its behalf. Over-centralisation is perhaps the greatest danger in both States—a danger which is at a minimum now owing to the personalities in actual control. We were all greatly indebted to the authorities for the descriptive literature provided, and no better statement of the general position of Australian education is to be desired than that written by Prof. Anderson in the handbook provided by the Commonwealth for the association.

RECENT ASPECTS OF MUTATION.[1]

IN recent years significant developments have taken place in connection with the study of mutations; indeed, these developments are so numerous that only a few of them can be mentioned now. The genus Œnothera has continued to be a storm-centre around which many controversies have raged, but of late a number of these questions appear to have been definitely settled. Among the recent developments may be mentioned first the authentication of *Œ. lamarckiana*, Ser., as an endemic species of the North American flora. The specimen collected by Michaux some time during his travels in eastern North America between the dates 1785 and 1796, which is now in the Muséum d'Histoire naturelle in Paris, and to which de Vries has recently directed attention, proves that this species did not originate in cultivation, as has been so frequently surmised. This shows also that it could not have come from Texas in 1860, as was stated, and it may yet be found in Kentucky or perhaps in western Virginia. This belief is founded on several considerations which I need not enter into here.

In order to show that *Œ. lamarckiana* differs in no respect from several other species as regards its history and fate, let me trace the history of certain of these species. *Œ. biennis*, L., as it now grows on the sand-dunes of Holland, where it has been naturalised since early in the eighteenth century, is identical with a form cultivated at Oxford by Morison about 1660, from Virginia. Yet this form is not now known to occur anywhere in North America, though search may yet reveal it in its native home. This *Œ. biennis* was probably the first Œnothera to be taken to Europe, in 1614. It has remained for three centuries unmodified in its new habitat, though Stomps has recently shown that it gives rise to two mutations, *cruciata* and *sulphurea*, the latter of which was already recognised as a distinct variety by Linnæus in 1737, as Bartlett has shown. Another race of *Œ. biennis*, obtained originally from the Madrid Botanical Garden, contains several aberrant forms parallel to the *lamarckiana* mutations, including one resembling *laevifolia*, and it also produces *Œ. biennis lata*.

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[1] From a lecture delivered at the Marine Biological Laboratory, Woods Hole, Mass., on August 14, by Dr. R. Ruggles Gates.

The history of *Œ. parviflora*, L., is no less interesting. Morison grew it, and several early specimens are also found in the British Museum. Like *Œ. biennis*, it masqueraded under a pre-Linnæan polynomial. Unlike *biennis*, however, it does not seem to have become naturalised, in Europe, but it was preserved in botanic gardens until rediscovered by Miss N. M. Stevens in Maine in 1905, and described in full by MacDougal and Vail. *Œ. muricata* again was named by Linnæus, but had been introduced a century earlier, as shown by specimens in the Morison Herbarium.

Œ. angustissima has had a somewhat different history. I described this species from Ithaca, N.Y., last year, and afterwards found that Morison had cultivated a closely similar race of the same species. The latter probably came from Maryland, where I believe it still exists. Being a weaker species it has not only failed to become naturalised in Europe, but has long since disappeared from the botanic gardens.

It will thus be seen that the status of *Œ. lamarckiana* differs in no respect from that of other species, and experimental attempts to produce it by crossing two other species are bound to be futile. On the other hand, its open-pollinated habit allows of continual intercrossing of closely related races. But these races naturally occupied the same geographical area, and it is therefore useless to attempt, as has been done, to produce *lamarckiana* by crosses between two races or species which are geographically isolated from each other.

Another feature of *Œ. lamarckiana* which it shares with such species as *Œ. muricata* and *Œ. angustissima*, consists in the existence of several distinct races differing from each other in minor particulars. The Swedish race cultivated by Heribert-Nilsson differs from that of de Vries in a number of points, and resembles more closely the Œnotheras cultivated in English gardens. The latter also exhibit various racial differences in addition to the mutations. *Œ. lamarckiana* does not, therefore, consist of a single elementary species; and in this respect it resembles the majority of ordinary wild species. How these racial differences have originated is another question, but they are of a different order from the differences between the mutations. They exhibit one kind of diversity, the mutations another. In other words, there are here two kinds of polymorphism, and they should not be confused with each other.

The discovery that *Œ. lamarckiana* is an endemic North American species not only dispels the hypothesis that it might have originated in cultivation, but considerably weakens the Mendelian assumption that the mutants are merely hybrid combinations, and the mutation process a phenomenon of hybridisation. Since Bateson's original suggestion to this effect in 1902 nearly all the Mendelians have taken a turn at explaining the mutations in this way. We have heard of coupling of characters, duplication of gametes, and innumerable other hypotheses of this kind applied to the peculiarities of Œnothera. But it has long been obvious to critical students of Œnothera that although *Œ. lamarckiana* may be in some limited sense a hybrid, yet the mutation phenomena themselves come in a different category. And it has remained for the Mendelian assumption to be totally disproved by other lines of attack on the problem.

The analytical breeding experiments show that something other than Mendelism has to be dealt with in Œnothera, while the cytological work furnishes certain definite clues concerning the nature of the germinal changes involved. The evidence from every hand is so overwhelming that it can no longer be doubted that mutation is a phenomenon of variation, and not merely of inheritance, as Mendelians would have us believe.

It may perhaps be pointed out here that Mendelism is itself a theory merely of heredity, and a partial theory at that, dealing only with complete or discontinuous inheritance. The manner of origin of these inherited differences is a matter on which Mendelians have speculated much, and we have had complete evolutionary philosophies founded on the presence-absence hypothesis and the supposed universal "loss of factors" in the origin of *nova*. But it is obvious that a theory of inheritance, or even a knowledge of inheritance, does not necessarily throw any light on the *origin* of the differences the inheritance of which is considered. In point of fact, instances may be cited in which a character, the evolutionary development of which was very gradual, has been suddenly lost through a germinal change. It is then inherited in a discontinuous way in crosses with the "loss-mutation." The hornless condition in cattle is a case in point. To suppose that because a character is inherited in discontinuous fashion it has *necessarily* originated in a similar manner may therefore lead to wholly erroneous conclusions.

Experiment shows it to be equally untrue, conversely, that when a new feature originates suddenly it must always be inherited in Mendelian or alternative fashion. It *may* be alternative, or it may give a permanently blended result, depending in part upon the organism with which it is crossed.

An example of this kind of behaviour has occurred in breeding experiments with *Œ.* mut. *rubricalyx*. This form originated as a heterozygous mutation from *rubrinervis*, its offspring splitting into *rubricalyx* and *rubrinervis* in a simple 3 : 1 ratio, the red pigmentaton of *rubricalyx* being dominant. Extensive crosses have been made between *rubricalyx* and *Œ. grandiflora*, Solander. The latter species differs throughout from *Œ. lamarckiana* and its derivatives. The most striking differences are in foliage, buds, pubescence, and physiological reactions, *Œ. grandiflora* developing more rapidly at certain stages, and being adapted to a more southern climate.

In *grandiflora* × *rubricalyx* and its reciprocal, the F_1 hybrids are intermediate in foliage and other features, but the *rubricalyx* pigmentation is essentially dominant, though the depth of red is paler than in the *rubricalyx* parent. When the *rubricalyx* parent was heterozygous for the red (R) the F_1 contained, as anticipated, 50 per cent. with red buds (R) and 50 per cent. with green buds (*r*). In the F_2 families sharp segregation usually took place, but a few rare cases were found in which the red pigmentation had not behaved as an unmodified unit-factor, but was intermediate, *i.e.* the sepals were paler red with only traces of red on the hypanthium. By selfing such individuals it was found that a new and intermediate condition of pigmentation had been obtained, for the F_3 offspring bred true to the condition of their parent. In this way a sharp unit-character which has originated through a mutation may be permanently modified by crossing with another species.

By back-crossing the ordinary F_2 offspring again with *grandiflora* the pigmentation is also further diluted, and new conditions of stability in pigmentation are reached. Many of the details of these experiments have already been published, and here attention is merely directed to the fact that the Mendelian 3 : 1 ratio with sharp alternation between the characters appears to depend upon a condition of balance in the organism. If this condition of balance is disturbed by crossing with another species having a different metabolism then the character in question may be modified, diluted, and blended, even though it originally appeared sharply and suddenly through a mutation in the race.

Returning to the previous line of argument, it should therefore be obvious that no theory of heredity, either Mendelism or any other, is adequate to account for the *origin* of characters, and Mendelians are responsible for much confusion of thought in failing to observe the fundamental distinction between the origin of a character and its subsequent inheritance. It is the *origin* of the character, the nature of the change involved in its appearance, and the manner and causes of its apparition, with which mutationists are primarily concerned.

It is, therefore, only after analysing many actual cases of mutation, and determining the nature and causes of the germinal changes involved in each, that generalisations can be made regarding the nature and significance of the mutation process. This has been done most completely in Œnothera among plants, and by the experiments of Morgan and his students with Drosophila among animals. Without drawing comparisons between the two series of observations and experiments, which differ in many features, reference may be made to a few of the points of view to which the work with Œnothera has led.

In the first place, as already pointed out, it has become clear and indisputable that mutation is a phenomenon of variability and not merely of inheritance. The breeding experiments and the cytological investigations have co-operated in proving this thesis, and thus eliminating the swarm of Mendelian hypotheses. In the second place, we now know that mutation, at least in Œnothera, is a composite process. Each mutation is in a new direction, and represents a different kind of germinal change. It is quite erroneous to suppose, as Heribert-Nilsson has done, that the various mutations of Œnothera fall into plus and minus series. Any such classification is of the most superficial kind, and the cytological investigation of the various mutants has done more than anything else to throw light upon the real nature of the change involved in each case.

It may be worth while to observe here that the multifarious nature of mutations, representing as they do departures in many directions from the parent stock, is in harmony with present conceptions of certain general features of animal phylogeny, according to which many lines of divergence appear to have departed simultaneously from a common stock. On the other hand, orthogenetic phylogenies, of which there appear to be many examples in the palæontological record, must depend upon other principles which are not here considered.

When we analyse cytologically the different mutants of Œnothera they are seen to fall into at least four or five categories. We may mention :—

1. Duplication of a single chromosome to give 15.
2. Hypothetically, in a case soon to be published, a second duplication, to give 16 chromosomes.
3. Triplication of the whole gametophyte series of chromosomes, giving 21.
4. Duplication of the whole sporophyte series, giving 28 chromosomes.
5. The large class of mutations in which no change in chromosome number occurs.

The latter will be referred to again later. They really include many diverse types of change, and only agree in not having a visible structural change in the nucleus.

The peculiarities of the mutants *lata* and *semilata* are constantly associated with the presence of fifteen chromosomes instead of fourteen. In 1908 the meiotic irregularity which leads to the formation of a germ cell, and later an individual, having an extra chromosome was first observed. The same unequal chromosome distribution has since been observed in several derivatives of *Œ. lamarckiana*, and also in wild *Œ. biennis* from Woods Hole, showing that these are all capable of producing *lata* mutations. It seems obvious that the mutation occurs when a chromosome passes into the wrong germ cell in meiosis, and that the peculiarities in foliage and habit exhibited by *lata* and *semilata* result from the fact that all the nuclei of the plant contain a complex of fifteen instead of fourteen chromosomes. The extra chromosome is, evidently from its origin, a triplicate of a pair already present in other forms, and apparently any member of the seven pairs may become the extra chromosome. The obvious resemblances and differences between this and the accessory or sex chromosomes need not be considered here.

The phenomenon of tetraploidy, now known to be exhibited by many species of plants and animals, first derived evolutionary significance from the fact that *Œ.* mut. *gigas*, which de Vries found to originate suddenly from *Œ. lamarckiana*, is tetraploid, having twenty-eight chromosomes. The tetraploid species of Hieracium, Antennaria, Drosera, Viola, Gyrostachys, Potentilla, and many other genera have obviously originated in a similar manner, and in the phylogeny of some families this doubling has occurred two or three times successively, so that the process is one of much evolutionary interest. The precise manner in which the doubling of the chromosome series occurs is not yet entirely clear, but it is obviously a different process from the duplication of one chromosome which gives rise to *lata*.

In the majority of mutations there is no obvious morphological change in the cell, and it appears that in such cases the ultimate change is chemical. These mutations fall into several categories differing in their hereditary behaviour. Although this matter is too involved to consider in detail here, reference may be made to what appears to be the probable basis of mutations which exhibit simple Mendelian behaviour when crossed with their parent race. We may take as an example the case of *Œ.* mut. *rubricalyx*, which originated from *rubrinervis* in cultures in 1907, and has never occurred before or since so far as known. The original mutant was heterozygous, its offspring yielding *rubricalyx* and *rubrinervis* in the ratio of 3 : 1. A homozygous race has since been obtained.

The origin of such a mutant can be adequately explained on the assumption that the substance of a single chromosome underwent a chemical change of such character that the activities of the chromosome in the whole complex of the cell led to the production of quantities of anthocyanin where it had not been produced before or where it had been produced only in small amounts. Of course, this change may be confined to one portion of a chromosome, and does not necessarily affect the whole body of the chromosome. The behaviour of mutations which exhibit a simple dominant or recessive unit-difference is fully accounted for by this hypothesis. It may be said that this merely assigns the phenomenon to the chromosomes without further analysing it. But such hypothetical changes in chromosomes are strictly analogous to the mutations which many bacteria are now known to undergo, and if such simple organisms as bacteria can experience sudden changes in structure and function it is in no way improbable that chromosomes can do likewise.

We may even explain in this way the origin of "duplicate genes," such as have been described by Nilsson-Ehle in wheat. In some families he obtained a ratio of approximately 15 : 1 for red, and absence of red in the glumes; in other families the ratio 3 : 1 was obtained. It appears that in the former case two independent "determiners for red" are present in the germ cells. This condition receives a reasonable explanation if we assume that two chromosomes, belonging to different pairs, have each undergone the change which leads to the production of red in the glumes.

It would take us too far to attempt to analyse the various other types of mutations which are now known to occur, but we may refer to one other case. The origin of *Œ.* mut. *nanella* cannot be explained in the same way as that of *Œ.* mut. *rubricalyx*, for its hereditary behaviour is different. Not only is *nanella* recessive in comparison with *rubricalyx*, which is dominant, but when we cross *lamarckiana* with *nanella* we obtain both parent forms in F_1, and both afterwards breed true. If the behaviour were Mendelian, the dwarfs should appear first in the F_2. On the other hand, *rubrinervis* × *nanella* produces *lamarckiana* and *rubrinervis* only in the F_1, and *nanella* in the F_2. The only explanation of this behaviour that has been offered is de Vries's hypothesis of labile pangens. However we picture the change from *lamarckiana* to *nanella*, it has happened differently from the mutations previously mentioned, and de Vries's supposition that splitting in such cases occurs in F_1 or F_2 according to whether the character is present in the labile or stable condition is the only hypothesis that meets the case.

From the instances already mentioned it will be seen that mutation is a multifarious process, and the greatest need of the present time is the analysis of many individual cases through combined cytological and experimental study. Such analyses will lead to a better understanding of the nature of germinal changes and the way in which they contribute to evolutionary progress. The study of inheritance, Mendelian or otherwise, is useful and entertaining, but behind it lies the question as to how and why Mendelian and other differences arise. We have seen that a bewildering variety of germinal changes occurs, and their study opens a vast field of investigation which has scarcely as yet been touched upon. When we know more of the nature of germinal changes and the laws and causes of their occurrence it should be possible to apply the knowledge more directly to problems of phylogeny.

To me, the most significant distinction between mutations and fluctuations, or germinal changes and continuous variations, lies in the fact that the former are inherited as wholes, though it may be only in a fraction of the offspring; while the latter are partially inherited and are also more amenable to the environment. Darwin relied chiefly upon what we call continuous variations, because the complete inheritance of "single variations" or mutations was then unknown. It does not follow, however, that the latter furnish the whole of the material for evolution, and I am inclined to believe in a large borderland between these two categories of variations, which is at present unexplored.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE London County Council has arranged for a series of five lectures entitled "The Natural History of Some Common Animals," to be given at the Horniman Museum, Forest Hill, on Wednesday evenings, at 8 p.m., commencing yesterday. The lectures will be illustrated by lantern slides and specimens; each will be complete in itself, and there will be no charge for admission.

WE have received from the University of Sydney a copy of an interesting publication entitled "Bibliographical Record of the University of Sydney, 1851–1913." It is chiefly composed of lists of the publications of the members of the University staff, and of its research scholars. The titles of original papers in the various subjects of university study, and of treatises and text-books published from time to time, run to eighty-four closely printed pages, and form excellent testimony to the ability and industry of the members of the University and to the value of their contributions to our knowledge.

WE are informed that the 1914–15 session of Hongkong University commenced on September 14 with a good entry of students; eight entered from the province of Chihli and several from the Straits, Shanghai, etc. Since the last session the staff has also increased, the latest addition being Mr. W. Brown, a lecturer in mechanical engineering. There are now seventy-six students in the university studying engineering, and the British staff in the engineering faculty consists of the Taikoo professor, five lecturers and an electrician. Numerous visitors are attracted by the magnificent equipment presented by British manufacturers.

A SUPPLEMENT to the original "Catalogue of Books on the Useful Arts" in the central libraries of Newcastle-upon-Tyne, which was published in 1903, has been prepared by Mr. Basil Anderton, the public librarian, and issued by the Public Libraries Committee. The present catalogue covers the accessions to the library during the years 1903–14 and includes the titles of volumes in the lending libraries as well as those in the central reference library. Dewey's decimal classification is adopted, and the index will guide readers straight to the group of books they desire. Mr. Anderton and his staff may be congratulated not only upon the excellence and completeness of their catalogues, but also upon the comprehensive collection of technical literature which they have been enabled to provide for the use of students in their area.

THE issue of *Science* for October 23 contains the following announcements of bequests and gifts in aid of higher education in the United States. Phillips Academy, Andover, Mass., receives a bequest of about 92,400*l.* under the will of the late Mr. Melville C. Day, of New York, who died in Florence, Italy. This amount is the residue of the estate. At the termination of a life estate created for the benefit of a friend, Phillips Academy will receive a further sum of about 9000*l.* The late Mr. F. W. Dohrmann, for a number of years a regent of the University of California, has bequeathed 1000*l.* as a loan fund, for loans to members of the faculty to tide them over times of illness or other emergency. Miss Ellen B. Scripps has made a gift of 7000*l.* (in addition to 12,000*l.* previously subscribed by herself) for a pier, pumping plant, and additional equipment for the Scripps Institution for Biological Research, at La Jolla, near San Diego, California. For its maintenance she gives 2000*l.* yearly to the University of California.

A CERTAIN number of Belgian professors are now assembled at Cambridge, as well as an increasing number of students from Louvain, Liège, Ghent, and Brussels. In view of the appeal issued by the Belgian Government for volunteers, it has been decided in consultation with the Belgian Government, that only such students as are physically unfit for military service, or have been rejected for other reasons by the Belgian authorities, and are in possession of a certificate to that effect, can be accepted by the Cambridge hospitality and academic committees. It has proved impossible for Louvain University to transfer its corporate and official existence to Cambridge, and consequently no attempt is to be made to organise official courses of study, to institute examinations, or to grant diplomas. But an endeavour is being made to combine systematic instruction on the lines of the Belgian universities with the requirements of refugee students and the possibilities of an incomplete Belgian teaching staff. The faculties of philosophy and letters, law, and engineering are so far most favourably placed. All students making application are asked to give their name, faculty, and university, and to state whether they require hospitality or can contribute to their maintenance. All applications should be sent to Mr. J. T. Sheppard, King's College, honorary secretary of the general committee, or to Mr. E. Bullough, Gonville and Caius College, honorary secretary of the academic committee.

The November issue of the *British Review* includes an article by Mr. J. G. Vance, on the University of Louvain. The University was founded in 1425, but as it was before the arrival of the invading Germans in Louvain, it had known only eighty years of life. Mr. Vance traces its varying fortunes from its foundation until the beginning of the nineteenth century; but the most interesting and illuminating part of his essay is his sympathetic account of the part the University has taken in the national life of Belgium in recent times. In 1834 the undergraduates numbered only eighty-six; after twenty-four years of vigorous life, there were fewer than 800; in 1855, about 1700; in 1909, about 2300; while within the last year the total has run up to 3000. Yet Belgium, with a total population of some seven millions, has four universities. No subsidy or grant of any kind has ever been received by the University from the State, the province, or the commune. The University is maintained entirely by the devotion and sacrifice of Belgian Catholics. "Rich and poor have contributed now for some eighty years to build up the University, which has been a common charge and a common burden. Every priest holding any position in any of the six Belgian dioceses pays an annual university tax, varying according to his rank and means, from five to a hundred francs. In every Catholic chapel and parish church there are two collections every year on behalf of the university, which is known to every Catholic, whether he be farm-labourer or barrister, as 'alma mater.' Lastly, a house-to-house visitation is made once a year by the curé of all the parishes, with a view of collecting and encouraging subscriptions for the same purpose."

A copy of the calendar for the current session of the University of Sheffield has been received. It gives full particulars of courses of instruction provided in the various faculties in preparation for the degrees and diplomas of the University. In common with our other modern universities, the University of Sheffield has a flourishing faculty of applied science in which degrees of bachelor, master, and doctor of engineering and metallurgy are conferred under the conditions specified in the calendar. A bachelor of engineering degree in mining has also been instituted. For students who for various reasons do not find it convenient to graduate, courses for associateships in the faculty of applied science have been arranged. Among numerous other arrangements made to meet the needs of the community served by the University may be mentioned a two years' course of work in the University and the Sheffield Training College of Domestic Science. The scientific portion of the work is taken at the University, and the technical studies in cookery, laundry, and housewifery at the training college. The calendar also gives details of a comprehensive scheme of University extension work designed to provide the means of higher education for persons who are engaged in the regular occupations of daily life. The University is also able to offer for competition a generous supply of scholarships, fellowships, exhibitions, and prizes. The arrangements in the more ordinary faculties comprised in University work are very complete and compare favourably with those of other institutions of higher learning.

SOCIETIES AND ACADEMIES.

London.

Royal Society, November 5.—Sir William Crookes, president, in the chair.—Sir William **Crookes**: Acquired radio-activity. Various objects, diamond, ruby, garnet, quartz, gold, platinum, etc., also the phosphorescent substances yttria, calcium sulphide, zinc blende, and barium platinocyanide, are bombarded in a high vacuum by kathode rays, and in no case can any permanent activity be recognised either by photographic or electrical means. Exposure to radium emanation confers temporary radio-activity on all bodies that have been tried, apparently due to the condensation of the emanation on the surface. This transient activity can be completely removed by washing in dilute acids. Many substances become coloured by direct exposure to radium, the colour depending on the substance. Diamond takes a full sage-green tint, the depth of tint depending on the time of exposure to the radium. In addition to change of colour, diamond also becomes persistently radio-active, continuously giving off α, β, and γ rays. The acquired colour and activity withstand the action of powerful chemical agents, and continue for years with apparently undiminished activity. Removing the surface by mechanical means removes both colour and radio-activity. The appearance of an auto-radiograph made by placing an active diamond crystal on a sensitive photographic plate, and the visual examination of its "scintillation" luminosity, suggest that there is a special discharge of energy from the corners and points of the crystal.—Hon. R. J. **Strutt**: Luminous vapours distilled from the arc, with applications to the study of spectrum series and their origin. II. (1) The conducting properties of a luminous jet of mercury vapour distilled from the arc *in vacuo* have been examined. The current depends on the shape and position of the kathode introduced into the jet, and is independent of the position of the anode. In the case where the anode is reached first by the stream of vapour, and a net electrode is used as kathode, all the positive ions may be taken out of the vapour that passes through the kathode. (2) The luminosity of the jet is unaffected by the removal of negative ions at the anode, but is quenched by removal of positive ions at the kathode. Although the removal of negative ions in the latter case is not complete, it is considerable enough to show conclusively that the luminosity is independent of the number of negative ions present. Thus the luminosity is not due to recombination of ions. (3) Experimenting with other metals as well as mercury, it is found that the various lines of a spectrum are not, in all cases, equally extinguished when the jet of luminous vapour passes through a negatively electrified net. Thus the lines of the subordinate series of the sodium spectrum apparently all lose intensity in the same ratio; but the D line of the principal series is much less affected. (4) The jets formed by arsenic and antimony, which show band spectra consisting of large numbers of uniformly spaced bands, are not quenched by passing through a negatively electrified net. The luminous centres appear therefore to be uncharged in these cases.—Prof. J. N. **Collie**, H. S. **Patterson**, and I. **Masson**: The production of neon and helium by the electrical discharge.—Prof. C. H. **Lees**: The flow of viscous fluids through smooth circular pipes.—F. O. **Rice**: Quantitative measurements of the absorption of light. I.—The molecular extinctions of the saturated aliphatic ketones. The absorptive power of fourteen of the saturated aliphatic ketones has been measured quantitatively with an ultra-violet spectro-photometer. It was found that previous observations by other authors were inaccurate owing to the presence of impurities in the ketones. The general results of the present observations are considered from two points of view, namely, the position of the absorption band and the maximum absorptive power. The wave-length of the absorption band depends upon the number and position of the alkyl groups in the side-chain, and tends to increase with the number of CH_3 or CH_2 groups.—Prof. W. M. **Thornton**: The ignition of gases by condenser discharge sparks.—E. G. **Bilham**: The spark spectrum of nickel under moderate pressures.

CAMBRIDGE.

Philosophical Society, October 26.—Dr. Shipley, president, in the chair.—H. H. **Paine** and G. T. R. **Evans**: The conductivity of extremely dilute acid and alkali solutions.—N. **Wiener**: Studies in synthetic logic.

PARIS.

Academy of Sciences, October 27.—M. P. Appell in the chair.—Gaston **Darboux**: Partial differential equations of the second order with two independent variables and the relations of Laplace formed with such equations.—André **Blondel**: The theory of alternators.—M. **Coggia**: Observation of Lunt's comet 1914*b* made at the Marseilles Observatory. Position given for October 21.—M. **Bigourdan** communicated a telegram received from Comas Solà, director of the Fabra Observatory at Barcelona, giving the positions of a comet, possibly Encke's comet.—B. **Berloty**: Observation of the solar eclipse of August 21, 1914, at Ksara.

NEW SOUTH WALES.

Linnean Society, July 29.—Mr. C. Hedley, vice-president, in the chair.—E. F. **Hallmann**: A revision of the Monaxonid species described as new in Lendenfeld's "Catalogue of the Sponges in the Australian Museum." Part ii. The second part of the revision deals with the species (twenty-four in number) assigned by Lendenfeld to the families Homorrhaphidæ and Heterorrhaphidæ. Of these, five have not been identified; the remainder have been redescribed and figured. With few exceptions, the original descriptions have been found to be inaccurate and misleading, a number of them even confusing the external features of one species and the internal features of another; and, in the case of two of the species, the figures given are those of sponges not described in the catalogue at all.—J. H. **Maiden**: Further notes on the botany of Lord Howe Island. Part v. A description of a species of Plantago deemed to be new is offered. The paper contains notes on the vegetation of the summit of Mt. Gower by Mr. Hedley, who, and also Mr. W. S. Dun, placed his collections at the disposal of the author. Notes on the vegetation of the Admiralty Islets are given, together with critical observations on some introduced and other plants, the occurrence of which on the island was hitherto considered to be uncertain. Some notes on synonymy are included.—E. **Breakwell**: A study of the leaf-anatomy of some native species of the genus Andropogon (N.O. Gramineæ). Plants representative of seven species have been examined. In respect of anatomical structure, these fall into three groups.

August 26.—Mr. W. S. Dun, president, in the chair.—E. F. **Hallmann**: A revision of the Monaxonid species described as new in Lendenfeld's "Catalogue of the Sponges in the Australian Museum." Part iii. The concluding part of the revision deals with the families Desmacidonidæ and Axinellidæ. Several of the species described are new—among these being *Histoderma actinioides* and *Raspailia agminata,* examples of which are figured in the catalogue erroneously, in illustration of *Stylotella polymastia* and *Halichondria rubra* respectively.—F. H. **Taylor**: The Culicidæ of Australia. Part i. Seven species, referable to six six genera—Stegomyia (1), Ædimorphus (1), Culicada (2), Culex (1), Skusea (1), and Menolepis? (1)—are proposed as new, together with one variety. Additional records, for a number of previously known species, are included.—W. N. **Benson**: Petrological notes on various New South Wales rocks. The paper describes briefly collections made in various parts of New South Wales. Nullum Mountain, near Murwillumbah, consists of granophyre intrusive into Palæozoic schists. It is associated with dykes of trachyandesite, and a rock composed almost entirely of andesine. A well-known basalt-dyke at Gerringong contains abundant inclusions of alkali-felspar gneiss, granodiorite-gneiss, quartz-schist, and a few inclusions of gabbro. Interesting reactions occur between the xenoliths and basalt. Granitic inclusions are recorded from the volcanic necks of Dundas and Norton's Basin. The peculiar, green, fibrous decomposition-product of olivine, that occurs in the basic xenoliths of Dundas, and in the majority of the olivine-basalts of the Sydney district, is recognised as bowlingite.

BOOKS RECEIVED.

Water Supplies: their Purification, Filtration, and Sterilisation. By Drs. S. and E. K. Rideal. Pp. ix+274. (London: Crosby Lockwood and Son.) 7*s.* 6*d.* net.

Royal Observatory, Hong Kong. Report on the Time Service. Pp. 19. (Hong Kong.)

A First Book in Psychology. By Prof. M. W. Calkins. Fourth edition. Pp. xxi+428. (London: Macmillan and Co., Ltd.) 7*s.* net.

English Humour in Phonetic Transcript. By G. Nöel-Armfield. Pp. xv+73. (Cambridge: W. Heffer and Sons, Ltd.) 1*s.* 3*d.*

Transactions of the Paisley Philosophical Institution, 1914. The Abbey Hazel Nuts: their Geological and Historical Significance. By Rev. C. A. Hall and D. Smith. Pp. 31. (Paisley: A. Gardner.) 6*d.*

City and County of Newcastle-upon-Tyne. Public Libraries Committee. Catalogue of Books on the Useful Arts in the Central Libraries, 1903–14. Edited by B. Anderton. Pp. viii+209. (Newcastle-upon-Tyne: Public Library.)

Technical Gas Analysis. By Dr. G. Lunge. Pp. xv+407. (London: Gurney and Jackson.) 15*s.* net.

Technical Methods of Chemical Analysis. Edited by Dr. G. Lunge and collaborators. English translation edited by Dr. C. A. Keane and collaborators. Vol. iii., part 1. Pp. xxxi+538. Vol. iii., part 2. Pp. xv+539–1125. (London: Gurney and Jackson.) 3*l.* 3*s.*

The Whip of God. By R. H. McCartney. Pp. 30. (New York: C. C. Cook.)

Catalogue of Coins in the Colombo Museum. Part i. Muhammadan and European (exclusive of Roman). By H. W. Codrington. Pp. 61. (Ceylon.)

Bibliographical Record of the University of Sydney. 1851–1913. Pp. 94. (Sydney: The University.)

Ministry of Finance. Egypt. Survey Department. Meteorological Report for the Year 1912. Pp. xxii+237. (Cairo: Government Press.) P.T. 30.

Meteorology of Australia. Commonwealth Bureau of Meteorology. Vol ii. Nos. 2 to 13. (Melbourne: A. J. Mullett.)

The Story of Yone Noguchi. Told by Himself. Pp. xi+255. (London: Chatto and Windus.) 6*s.* net.

Reason and Belief. By Sir Oliver Lodge. Third edition. Pp. xii+212. (London: Methuen and Co., Ltd.) 1*s.* net.

A History of British Mammals. Part xvi. (London: Gurney and Jackson.) 2*s.* 6*d.* net.

Jute and Linen Weaving. By T. Woodhouse and T. Milne. Second edition. Pp. xxvii+590. (London: Macmillan and Co., Ltd.) 12*s.* net.

A Class-Book of Commercial Knowledge. By E. J. Balley. Pp. viii+125. (London: G. Bell and Sons, Ltd.) 1*s.* 6*d.*

The Manufacture of Organic Dyestuffs, by Prof. A. Wahl. Translated by F. W. Atack. Pp. xiv+338. (London: G. Bell and Sons, Ltd.) 5*s.* net.

Great Colliery Explosions and their Means of Prevention. By Dr. W. Galloway. Pp. 130. (London: *Colliery Guardian* Co., Ltd.)

Crystallography: an Outline of the Geometrical Properties of Crystals. By Prof. T. L. Walker. Pp. xiv+204. (New York: McGraw-Hill Book Co., Inc.; London: Hill Publishing Co., Ltd.) 8*s.* 4*d.* net.

The Raw Materials for the Enamel Industry and their Technical Technology. By Dr. J. Grünwald. Translated by Dr. H. H. Hodgson. Pp. viii+225. (London: C. Griffin and Co., Ltd.) 8*s.* 6*d.* net.

The "Wellcome" Photographic Record and Diary, 1915. Pp. 280. (London: Burroughs Wellcome and Co.) 1*s.*

Geology of To-day. By Prof. J. W. Gregory. Pp. 238. (London: Seeley, Service and Co., Ltd) 5*s.* net.

Supplement to the Indian Journal of Medical Research. Proceedings of the Third All-India Sanitary Conference, held at Lucknow, January 19 to 27, 1914. Vol. ii., Papers. Vol. iii., Papers. Vol. iv., Papers. Vol. v., Papers. (Calcutta: Thacker, Spink and Co.)

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 12.

ROYAL SOCIETY, at 4.30.—Analyses of Agricultural Yield. I.: Spacing Experiments with Egyptian Cotton: W. L. Balls and F. S. Holton.—The Fixation of Arsenic by the Brain after Intravenous Injections of Salvarsan: J. McIntosh and P. Fildes.—The Production of Anthocyanins and Anthocyanidins. II.: A. E. Everest.—Living Observations on the Life Cycle of a New Flagellate—*Helkesimastix faecicola*, together with Remarks on the Question of Syngamy in the Trypanosomes: H. M. Woodcock and G. Lapage.—The Antagonistic Action of Carbon Dioxide and Adrenalin on the Heart: S. W. Patterson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Cables: C. J. Beaver.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting. Presidential Address: Mathematical Research; Prof. Love.

FRIDAY, NOVEMBER 13.

ALCHEMICAL SOCIETY, at 8.15.—The Movement of Alchemical Research in France: Actual Traces of Transmutation: W. de Kerlor.

ROYAL ASTRONOMICAL SOCIETY, at 5.—A Class of Asymptotic Orbits in the Problem of Three Bodies: A. H. Warren.—The Proper Motions of the Stars in Carrington's Circumpolar Catologue in Relation to their Spectral Types: F. W. Dyson.—The Stability of Direct and Retrograde Satellite Orbits: F. R. Moulton.—An Efficient Slow Motion Gear: W. S. Franks.—Partial Eclipse of the Sun, 1914, August 21, Observed at Armagh: J. L. E. Dreyer.—(1) Note on the Franklin-Adams Chart. (2) Natural Sines and Cosines in R.A.: O. R. Walkey.—The Determination of Fundamental Photographic Magnitudes: J. Halm.—Observations made during the Partial Eclipse of the Sun, 1914, August 21, at the University Observatory, Warsaw: S. Tscherny.—Note on the Nebular line λ3729: W. H. Wright.—The Partial Eclipse of the Sun, 1914, August 21, Observed at South Kensington: A. Fowler.—Note on the Meaning of the So-called Third Star Stream, Drift O: H. H. Turner.—Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1913: Royal Observatory, Greenwich.—*Probable Papers:* The Temperature Coefficients of Edinburgh Transit Circle: R. A. Sampson.—The Best Geographical Site for a Solar Observatory: J. Evershed.—Observations of the Transit of Mercury, 1914, November 5: Royal Observatory, Greenwich.—(1) The Absorption of Light in Space. (2) Account of the Eclipse Expedition to Minsk: H. S. Jones.

PHYSICAL SOCIETY, at 8.—A Bridge for the Measurement of Self-Induction: D. Owen.—The Coefficient of Diffusion in Dilute Solutions: B. W. Clack.

TUESDAY, NOVEMBER 17.

INSTITUTION OF CIVIL ENGINEERS at 8.—Economics of Electric Railway Distribution: Dr. H. F. Parshall.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Stone Implements from Gravel Beds in South Africa, with Notes: R. A. Smith.—The Prehistoric Pottery of the Canary Islands: Hon. J. Abercrombie.

WEDNESDAY, NOVEMBER 18.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Isomeric Rainfall Maps of the British Isles: Dr. H. R. Mill and C. Salter.—A See-Saw of Temperature between England and Egypt: J. I. Craig.

ENTOMOLOGICAL SOCIETY, at 8.—New Mymaridæ from Tasmania: C. O. Waterhouse.

GEOLOGICAL SOCIETY, at 8.—A Raised Beach on the South Coast of Jersey: Dr. A. Dunlop.—Tachylite Veins and Assimilation Phenomena in the Granite of Parijs (Orange Free State): Prof. S. J. Shand.

THURSDAY, NOVEMBER 19.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Note on the Circulation of the Atmosphere: A. Mallock.—The Origin of the Indo-Gangetic Trough—commonly called the Himalayan Foredeep: Sir S. Burrard.—Approximately Permanent Electronic Orbits and the Origin of Spectral Series: G. W. Walker.—Spectroscopic Investigations in connexion with the Active Modification of Nitrogen. IV.: A Band Spectrum of Boron Nitride: W. Jevons.—An Additional Note on the Production of High Permeability in Iron: Prof. E. Wilson.

CHILD STUDY SOCIETY, at 7.30.—Development of the Practical Imagination in Children: Prof. T. P. Nunn.

LINNEAN SOCIETY, at 8.—*Hydrilla verticillata*, Caspary, a New British Plant: A. J. Wilmott.—The Mosses and Hepaticæ of West Falkland Islands, from the Collections of Mrs. Rupert Vallentin: C. H. Wright.—The Thysanoptera of the West Indies: R. S. Bagnall.

FRIDAY, NOVEMBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Effect of Vacuum on Steam-Turbines: G. G. Stoney.

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THURSDAY, NOVEMBER 19, 1914.

VITALISTIC BIOLOGY.

(1) *The History and Theory of Vitalism.* By Prof. H. Driesch. Authorised translation by C. K. Ogden. Pp. viii+239. (London: Macmillan and Co., Ltd., 1914.) Price 5*s.* net.

(2) *The Philosophy of Biology.* By Dr. J. Johnstone. Pp. xv+391. (Cambridge University Press, 1914.) Price 9*s.* net.

(1) It is a somewhat melancholy reflection for those who had the pleasure of listening to Prof. Driesch's brilliant lectures on "Vitalism" at King's College last year, that owing to the outbreak of the present war Prof. Driesch may be at this moment engaged in armed conflict with some of his then hearers. Few German men of science had more friends in England than Prof. Driesch, and few had a warmer appreciation of England. One of his very earliest pieces of work was accomplished in the marine station at Plymouth.

In the volume before us Prof. Driesch is dealing not with facts but with the history of the idea of vitalism, the idea, that is to say, that there is at work in organic beings some agency not to be discovered in inorganic things, and that the peculiarities of living matter are not to be explained by its physical and chemical structure, but by an organising "something" within, which continually modifies this structure in order to achieve an "end." Beginning with Aristotle, Driesch recounts for us the views of a series of vitalistic naturalists and philosophers ending and culminating in himself. It would indeed be a perilous undertaking were we to attempt to criticise in detail the account which he gives of the earlier vitalists, among whom are included, not only Aristotle and many of the older naturalists, but Kant, Lotze, and Schopenhauer, and it would have but little interest for the readers of NATURE. The scientific man, as distinguished from the metaphysician, takes only a minor interest in the views of early naturalists, who dealt with imperfectly known and ill-understood data, and still less in those of dealers in abstractions like Kant. Prof. Driesch, with a daring which we can only humbly admire, endeavours to make clear what Kant really meant. Perhaps we may remind him that another German philosopher, Paulsen, has defied anyone to find a rational meaning in a good deal of what Kant wrote, adding that it is only to be explained psychologically as due to the pull of tendencies which dragged Kant's mind now in one direction, now in another.

The book concludes, as we have intimated, with an account of Driesch's own views, but as these are pretty faithfully reproduced in the second volume which we notice in this review, we may defer criticism of them. We should like, however, to protest in the strongest manner against the scornful way in which Driesch refers to Darwin. "Darwin—left the question of variability open, a course which reduced his doctrine to the self-evident proposition that what was not capable of existence could not exist." "Darwinism—explained how, by throwing stones, one could build houses of typical style."

When we contrast the work of Darwin, based on a life-time of study and on the broadest possible survey of the fields of zoology and botany, with that of his critic, which may be described as an inverted pyramid based on myopic concentration on a few facts of development, and contrast, further, the influence which the theories of the two men have had on contemporary thought, we are forced to the conclusion that to Prof. Driesch, as to many of his countrymen, the Lord hath denied a sense of humour.

Darwin, taking for granted the known peculiarities of living beings seen every day around us, and pointing out the result of the impact of the known forces of the environment on these peculiarities, sought to prove that a world something like the present one must result from purely natural causes; he is neither mechanist nor vitalist. Driesch at the close of his book tells that he supposes phylogeny to be a "supra-personal evolution." Which view, we may ask, is more helpful as a working hypothesis?

(2) Mr. Johnstone's book may be perhaps described as a combination of Driesch and Bergson. Its object is to support vitalism, and to combat the mechanistic view of life. Mr. Johnstone, who is a biologist distinguished for his researches into problems of marine biology, has the merit of putting his case in clear, well-written language, and although he has to deal with philosophical problems he avoids philosophical technical terms as much as possible, so that the ordinary reader has little difficulty in following him. On the principle, apparently, that any stick is good enough to beat a dog with, Mr. Johnstone employs arguments of totally different, and somewhat incompatible, kinds to enforce his position. He begins with a chapter entitled "The Conceptual World," which is a statement of the idealistic position, and really assists him not at all. For this position merely affirms the fact, obvious on reflection, that experience as *I* receive it implies at least an *I* who perceives it, and who is as real as the experience. The logical outcome of this, as Driesch has phrased it, is, "The world is

my phenomenon," so that there must be at least one observer distinguished from what is observed. But in life and practice we all know, though we cannot prove, that there is a similar "*I*" behind many of the objects which we perceive, viz., our fellow men and women. How far there is anything similar to human personality behind the other animals and behind plants he would be a bold man who would say. So far, indeed, as this argument is valid, it is valid against physical science as much as against "mechanistic biology." The idealistic argument is followed by a long chapter, the object of which is to persuade us that there is something very mysterious and unchemical about the synthesis of carbohydrate by chlorophyll in the presence of sunlight.

We then reach the root of the matter, which is the impossibility of explaining on chemical and physical principles the growth of the organism through the embryonic stage from the egg. This, indeed, is the citadel of Driesch's position. We have to try to account for the fact that a portion of an egg or of a blastula of an Echinoderm is capable of giving rise to a whole organism, and Driesch has no difficulty in showing that there is no conceivable machine-like arrangement of parts which will account for this. But, indeed, one has only to read Weismann's hopeless attempts to explain the regeneration of limbs on his "determinant" theory to be convinced of this. The best answer to Driesch is this: "Suppose we admit that we cannot explain these phenomena by physics, what alternative explanation have you to offer?" Of course, we are all familiar with the answer: "Living beings are inhabited by 'entelechia,' which guide their activities towards predetermined ends." But such an answer does not assist us. To put forward an unknown entity as the cause of phenomena which we cannot unravel is not to explain, but in reality to give up the attempt at explanation.

"Materialism," as known to practical biologists, is really only the modest and praiseworthy attempt to penetrate a little into the working of living things by *comparing* the processes which go on in them with chemical processes in inorganic nature. But if everything is due to an entelechy, very many insoluble questions arise. Allied species are believed to be genetically related to one another; how are their different entelechies related? Is there a possibility of entelechies being modified? Or, again, if by inverting a frog's egg in the two-cell stage we can cause it to produce a double-headed monster, how is it that the entelechy is so easily baulked of its purpose? If, however, we assume that there are in eggs *organ-forming substances*—and in some cases we can prove this by direct observation, we may have to admit that these substances are very remarkable and unparalleled in inorganic objects, but at any rate we have hold of a concept with which we can work. For a substance can be divided into two, and it may be evenly distributed throughout an egg as in Echinodermata or localised as in Annelida and Mollusca, and thus we are enabled to understand why a portion of an Echinoderm egg will produce a whole organism, but why a part of a Molluscan egg will only produce a part of an organism.

Other instances of similar hypotheses could be mentioned which assist in binding together the facts observed in the behaviour of living things and in elucidating the laws which govern them. The use of such hypotheses may be regarded as neither vitalistic nor mechanistic, but as plain common-sense applications of the inductive method. In this way, and in this way alone, it seems to us, shall we ever make progress with "explanations" of the phenomena of life, for all "explanation" in the last resort consists merely in putting together similar things. When, however, we have finished with the explanations of Driesch, both as related by himself and as given by his admirer, Mr. Johnstone, we are left in a mental fog—no great guiding principles to bind together vital phenomena emerge, and the conviction grows that whatever be the right method of tackling the phenomena of life it is not that of Driesch.

E. W. M.

BRITANNIC GEOGRAPHY.

(1) *The British Empire beyond the Seas: An Introduction to World Geography.* By Dr. Marion I. Newbigin. Pp. xii + 351. (London: G. Bell and Sons, Ltd., 1914.) Price 3*s.* 6*d.*

(2) *The British Isles.* By Dr. F. Mort. Pp. xi + 231. (Cambridge University Press, 1914.) Price 3*s.*

(3) *Argyllshire and Buteshire.* By P. Macnair. Pp. x + 161. (Cambridge University Press, 1914.) Price 1*s.* 6*d.* net.

(4) *Geological Excursions round London.* By G. MacDonald Davies. Pp. vi + 156. London: T. Murby and Co., n.d.) Price 3*s.* 6*d.* net.

(1) MISS NEWBIGIN'S work is always lucid, and she brings the facts of geography into a happy correlation. The continental shelf of North America is thus connected (p. 110) with the accumulation of the Newfoundland Banks, and through them with the cod-fisheries. The size of Australian sheep-farms (p. 147) is explained by the peculiarities of the

rainfall. The climate of Cyprus is first discussed (p. 35) on account of its contrast with that of Mongonui in New Zealand. The world-wide view of phenomena is never absent, and a pupil who reads these pages will cease to regard the British Empire as so many isolated red patches on a map.

The various divisions of the Empire are arranged according to their climatic conditions. British Columbia is thus treated, as having a "maritime temperate climate," apart from Canada east of the Rockies, which "may be more justly compared with eastern Europe and temperate Asia." Agriculture and forestry are properly regarded as the fundamental industries that depend on climate, and many interesting statements are made as to the modes in which labour-difficulties have been met. The questions and exercises encourage further reading; we are, for instance, asked to consider the right food for our coolies, and what we should sell, as Egyptian peasants, in order to pay our taxes. We have noticed only one tiny slip; the question on p. 333, "Why do you think the islanders rejoice so greatly when this worm appears?" does not quite express the meaning of the author.

(2) Dr. Mort describes the British Isles in the modern manner that now appeals to secondary schools, and his references to the geological structure of the country are sufficient to lead the pupil to ask for more. In later work a school may well use the volume on the geography of its own county provided by the same educational press, and it will be found that Dr. Mort has laid a good foundation for more detailed local study. References to castles and the holding of gaps make us inclined to think that more might be made of the influence of structural features upon British history. No young mind that can appreciate the rise of the industries of Sheffield or of ship-building on the Clyde should remain unmoved at Portnaspania or the Roman Wall. The references to the Devon seamen (p. 133) are admirable. The illustrations are well selected to show varied types of scenery. The scarped plateau of Ben Bulben (Fig. 79) is due to limestone, and not, as is stated, to Millstone Grit.

(3) Mr. Macnair's acquaintance with the geology as well as the antiquities of his country makes him an excellent guide to the mountainous lands of Argyll and Bute. This volume of the Cambridge Geographies is issued with rounded corners, and is thus all the better as a companion for the numerous travellers who start from Glasgow for the sea-lochs and the isles. General considerations are introduced in the earlier pages, and we notice that the author, while laying stress on glacial erosion, points out that the fiords have been developed "along the geological grain of the country," and sometimes across this grain. He does not, however, refer to the probability of the weakening of the land by cross-fractures before the ice-action set in. We are glad to see an Oligocene rather than an Eocene age assigned (p. 22) to the Cainozoic lavas. The account of the geology of Arran is also well brought up to date. In the index to the geological map, however, the word "chalk" should be "Cretaceous"; and should not "ferriferous," on p. 59, be "ferrous"?

The diminution of the highland population through the attraction of other fields is strikingly seen in the fact that Argyll, on the edge of the prosperous Central Valley, has lost 30 per cent. of its population since 1831. The county was long a battle-ground, owing to its position between the lowland and the western isles, and the author well remarks that perhaps the greatest date in its history was the arrival of Columba at Iona in 563.

(4) London remains the home of sincere amateurs in natural history, and the quiet woods and byways on the edges of its basin in these days tempt the walker more and more. Mr. Davies guides us from convenient railway-stations to view-points or famous sections where we may appreciate the structure of the hills. A good coloured geological map is given as a frontispiece, and this handy book should soon become known to London students, and also to visitors from the Continent.

G. A. J. C.

NATURE STUDY FOR SCHOOL AND HOME.

(1) *A First Course in Plant and Animal Biology.* By W. S. Furneaux. Pp. viii+232. (London: University Tutorial Press, Ltd., 1914.) Price 2*s.*

(2) *A First School Botany.* By E. M. Goddard. Pp. xiii+191. (London: Mills and Boon, Ltd., 1914.) Price 2*s.* 6*d.*

(3) *Pond Problems.* By E. E. Unwin. Pp. xvi+119. (Cambridge: University Press, 1914.) Price 2*s.* net.

(4) *Wild Life in the Woods and Streams.* By C. A. Palmer. Pp. xv+206. (London: A. and C. Black, 1914.) Price 3*s.* 6*d.*

(5) *The English Year: Summer.* By W. B. Thomas and A. K. Collett. Pp. viii+341. (London: T. C. and E. C. Jack, 1914.) Price 10*s.* 6*d.* net.

TO-DAY the junior student of biology has his attention directed to function and behaviour, rather than to those structural features which claimed almost exclusively the interest of his predecessors of thirty years ago. This modern tendency is shown in the batch of books now before us.

(1) Mr. Furneaux, introducing his lesson-book for school-classes, tells us that his work "deals with living nature rather than with dead objects." Beginning with Amœba and the Yeast, he passes first to plant life, as illustrated by fern and flowering plant, and then to animal life, so far as it can be demonstrated by short lessons on butterfly, frog, pigeon, and a few common mammals. The grosser structure of flowering plants is discussed at some length; in the zoological section attention is directed chiefly to what may be seen by the pupils as they watch the living creatures. Indeed, the anatomical information is almost too meagre to be of use, and the classificatory schemes are faulty; for example, eagles and owls are placed in the same order of birds, while among the mammals the Ruminants are separated ordinally from the Ungulata, which are said to include the horse, ass, and swine! The book concludes with a chapter on human physiology extending to 25 pages. Distinctly useful as the book may prove to an earnest teacher, it leaves the impression of an attempt to include too much in the space allotted.

(2) Miss E. M. Goddard's book, "written to provide a course in elementary botany for the middle forms," and admittedly intended to be "useful to students preparing for examination," gives an excellent combination of practical exercises and clear explanations, illustrated by good, bold outline drawings. The pupil who works conscientiously through the physiological experiments, and laboratory and field observations described in this small volume will have won something better than examination successes—a well-grounded foundation for future study of plant life. On page 46 there is a curious slip of "corm" for "bulb," in a paragraph distinguishing these two favourites of the botanical examiner, which may puzzle the intending examinee.

(3) In "Pond Problems," Mr. E. E. Unwin has produced a noteworthy educational work. He deals only with aquatic insects, and no naturalist who appreciates the mode of treatment adopted will be surprised to find that the method of teaching was learned in the laboratory of Prof. L. C. Miall. Mr. Unwin has, indeed, given his fellow-teachers the benefit of his own lesson-notes. The nature of his method will best be realised from the fact that in 100 pages there are 397 questions, to most of which the pupils are left to find answers from their own observations. All the drawings and most of the photographic illustrations are excellent. Hints are given for the construction of simple but efficient pieces of apparatus, and the boys or girls who are fortunate enough to be taken through the course on the lines indicated will enjoy a "good time." Is it not a mistake to use the term "skin"—even with quotation marks and explanations—for the chitinous exoskeleton of an arthropod? Why not write "cuticle," and thus familiarise the student from the beginning with the essential difference between the secreted envelope and the true skin which forms it?

(4) With Mr. C. A. Palmer's contribution we pass from school-books to a play-book, for he has written a series of bright chatty notes on common animals in the form of letters to a young boy. Many of these are thrown into the anthropomorphic story-sketch which has been popular of late years, both in the United Kingdom and in America. The somewhat slight letterpress is illustrated by attractive drawings. Although the scene of "Dad's" zoological researches is ostensibly an English county, he describes and figures the trap-door nest of a Nemesia, which raises a certain degree of scepticism with regard to his other stories.

(5) Messrs. Thomas and Collett have produced a volume of popular natural history for the drawing-room, which in literary form, typographical finish, and illustrations is "a thing of beauty." The black and white sketches—drawn by Mr. A. W. Seaby—are mostly admirable, and there are some attractive reproductions in colour of notable landscapes, though a plain naturalist, with an old-fashioned preference for clear drawing, is grateful for the printed information that one of them represents "building the Rick"; "Digging out the Sand-pit" would have been equally credible as a title. The book is made up of a series of short chapters describing phases of country life through the months of June, July, and August. Animals and plants are discussed in relation to their surroundings, and the authors see birds and flowers with the artist's eye. The passion for the open so pervades the book that it will surely drive some readers "Along the River" and "Among the Grasses," if not "Below the Tidemark." In some of their explanations the authors are too dogmatic. Our British species of Erebia, for example, are not surviving members of "the Arctic fauna which flourished here in the Ice Age." They both belong to the distinctively Alpine group which is southern rather than northern in its affinity, and neither is to be found in the Arctic regions. The studies of bird and plant life are generally good, and the drawings of birds—at rest or in flight—are excellent, as are most of the plant sketches. In

the chapters devoted to insects, however, there are signs of want of touch between authors and artist. In the chapter on "Butterfly Flight" there is a drawing of a "Fritillary," which represents the plant, not the insect of that name; the "Little Blue resting," on p. 35, appears to have been drawn from a "Common Blue," while the "Female Emperor," on p. 104, is unmistakably *Arctia caia*, the "Common Tiger" moth. Such slips as these can, however, be easily rectified in a new edition.

G. H. C.

PRACTICAL DRAWING.

(1) *A Manual of Mechanical Drawing.* By J. H. Dales. Pp. xii + 181. (Cambridge University Press, 1914.) Price 3*s*. net.

(2) *Machine Construction and Drawing.* Book ii. By A. E. Ingham. Pp. xii + 180. (London: G. Routledge and Sons, Ltd., 1914.) Price 3*s*. net.

THE titles of these two books have been well chosen; in one the chief concern of the author is to ensure manipulative skill in instrumental *drawing*, and in the other to illustrate details of engineering *construction*.

(1) Those readers who take Mr. Dales as their guide will undergo a process of careful drilling in the use and maintenance of the scale, square, pencil, pen, and compass, by means of specially designed and carefully graduated sets of exercises, largely geometrical in character, followed by examples of the projection of various machine details, and completed by the preparation of a full set of working drawings of a screw-cutting lathe, fully dimensioned, with titles and descriptions, all executed in the style of the skilled professional draughtsman. Thus the book gives a course of organised training in the draughtsman's craft, valuable especially to students who afterwards enter a drawing office, for they will be ready to begin elementary design or other good work at once.

(2) Mr. Ingham has previously written an elementary book on the subject, and the present volume is intended as a continuation, suitable for more advanced students. It gives, with descriptions and simple calculations, a large number of well-selected examples representing modern engineering practice, arranged and classified in seven chapters headed respectively, "Power Transmission Appliances," "Gearing," "Steam Engines and Turbines," "Gas and Oil Engines," "Boilers and Fittings," "Machine Tools and Appliances," "Pumps and Compressors." The drawings are well printed and thoroughly workmanlike and have evidently been prepared by a highly qualified expert. The student's progress is tested from time to time by sets of suggestive examples in drawing, calculation, and design. The text-book is a very good example of its kind, and will give satisfaction wherever adopted.

OUR BOOKSHELF.

Essays and Addresses. By the late Prof. James Campbell Brown. Pp. x + 208. (London: J. and A. Churchill, 1914.) Price 5*s*. net.

MR. HENRY H. BROWN, who edits this volume, explains in the preface that this selection of essays and addresses has been published because of the many requests for copies of particular papers by the late Prof. Brown which Mrs. Campbell Brown has received but was unable to accede to because most of the essays had never been printed.

The papers are arranged in chronological order, and most of them are concerned with various aspects of pure and applied chemistry. The first, on technical chemistry, was the chairman's address to the Liverpool section of the Society of Chemical Industry, and was delivered in November, 1886. The last essay, on science applied to the detection of crime, was an address to the chemical, physical, and legal societies at the University of Liverpool in 1908. The scope of the volume can be gathered from the titles of some of the other papers: the ethics of chemical manufacture, a French view of German industries, the use and abuse of hypothesis, and chemistry as a profession.

The papers have been printed as nearly as possible in the shape in which they were delivered, and will be welcomed by their author's old pupils and friends, who will recognise many characteristic touches.

The Happy Golfer. Being some Experiences, Reflections, and a few Deductions of a Wandering Player. By H. Leach. Pp. vii + 414. (London: Macmillan and Co., Ltd., 1914.) Price 6*s*. net.

THIS is a brightly written book, full of the free air of the links and the sweet philosophy of the man who enjoys the simple life of the natural athlete. The author discovers in golf seven wonders, the fascination that grips, the traditions which never stale in the telling, the ubiquity of the game, St. Andrews the sacred Mecca of every golfing soul, the tragedy of the short putt, the three mighty men who share fifteen open championships among them, and the marvellous amateur eight times champion, and, lastly, the romance of the rubber-cored ball. On these as texts he dilates and prattles, then takes us all round the world searching for happy golfing hunting-grounds, returning finally to the best heaven-given links of the dear homeland. He talks of players and matches, of temperament and style, of courses and hazards. When he touches on what is generally called the science of the game he speaks wisely and not dogmatically. Not a single illustration of stance or grip disturbs the literary glamour of the page; and the mysteries of the underspin and the dynamics of the slice and the pull are as if they were not. There is no "science" in the book; but it is admirably human.

C. G. K.

A History of the Teaching of Domestic Economy. Written for the Association of Teachers of Domestic Subjects in Great Britain by Ailsa Yoxall. Pp. 58. (London: Knapp, Drewett and Sons, Ltd., n.d.) Price 6*d.*

THIS little book represents the first attempt to place on record an account of the growth of the teaching of domestic economy in Great Britain. The movement appears to have been started in earnest about 1840, when some instruction in needlework began to be given in national schools for girls and infants. From this date to the present time the importance of instruction of this character has been recognised increasingly, until to-day the Association of Teachers in Domestic Subjects includes no fewer than thirteen important local branches, receives direct recognition by the Government, and elects one of its members to represent it on the Registration Council. The subject is now also given a more scientific character and includes a practical and theoretical study of every aspect of housewifery. The book deserves the attention of all who are interested in vocational education for girls.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Newton and the Spectrum.

IN NATURE of November 5, 1914, p. 263, I notice in the Astronomical Column a statement to the effect that, in connection with spectrum analysis, Wollaston (1802) was the first to employ the slit. I therefore venture to send a copy of the following passage, contributed by me to the 1913 Journal of the Leeds Astronomical Society, published last September:—

"Almost all writers, who quote Newton's classical experiment, overlook or ignore the fact that, recognising the impurity of the spectrum formed by admitting the sunlight through a round hole, Newton suggested the use of a linear aperture. Here is the passage from pp. 59–60 of the 4th edition of the *Opticks* (Book I., Prop. IV.):—

"'Yet instead of the Circular Hole, 'tis better to substitute an oblong Hole shaped like a long Parallelogram with its Length parallel to the [refracting edge of the] Prism. For if this Hole be an Inch or two long, and but a tenth or a twentieth Part of an Inch broad, or narrower; the Light of the Image will be as simple as before, or simpler, and the Image will become much broader, and therefore more fit to have Experiments try'd in its Light than before.'

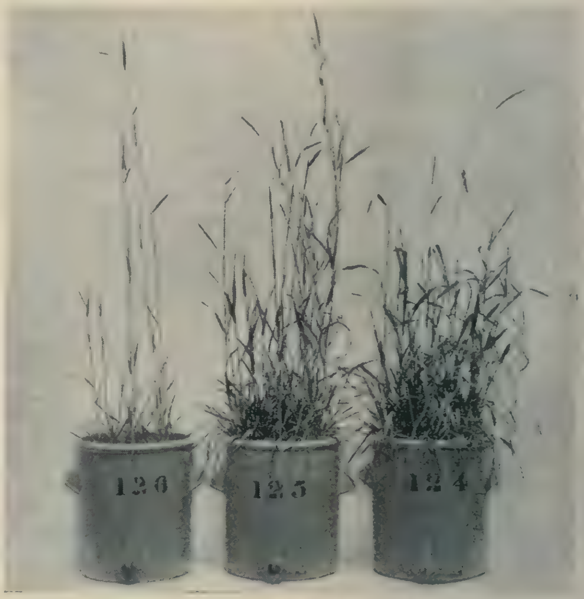
"It is not quite clear whether Newton actually tried this narrow aperture. I think he did; and it is interesting to consider that, if he had sufficiently narrowed the slit, and observed the spectrum directly by the eye, instead of observing it upon a screen, he might have discovered the dark lines."

C. T. WHITMELL.

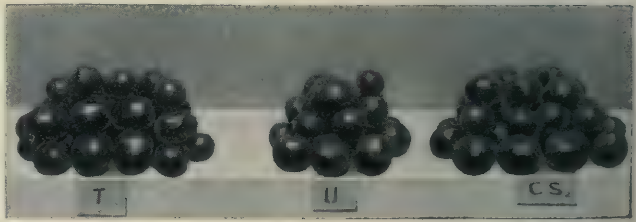
Invermay, Hyde Park, Leeds, November 9.

THE PARTIAL STERILISATION OF SOILS.

THE work to be described in this article arose, as so often happens, out of an accident in the laboratory. The writer was investigating the rate of oxidation of phosphorus, and during the progress of the work was called to take charge of an agricultural laboratory. Before finally disbanding the apparatus some observations were made on soils, and it was found that fertile soils absorbed oxygen more rapidly than non-fertile soils of the same character. Since the action was very considerably reduced in sterilised soils it was concluded that the process is largely due to the activity of micro-organisms, and the connection between oxygen absorption and fertility was attributed to the large part played by micro-organisms in the production of plant food.



Untreated soil. Partially sterilised soils (by toluene). (by heat).



Partially sterilised soil (by toluene). Untreated soil. Partially sterilised soil (by carbon disulphide).

FIG. 1.—Crops grown on untreated and in partially sterilised soils.

In doing the final confirmatory set of experiments the soils were only sterilised at 100° and not at 130°, in consequence of a mistake which caused some little annoyance at the time. An experiment was, however, carried out with this partially sterilised soil, and it led to the remarkable result that oxygen absorption is more rapid in such soil than in normal untreated soil. Other methods of partial sterilisation gave the same result. In view of the close connection between oxidation and productiveness, a set of pot experiments was put up, and these showed that the fertility of the soil was also increased after partial sterilisation. Typical results are illustrated in Fig. 1: the upper part gives experiments with rye, the lower part with tomatoes.

At this stage it was found that the fact had been discovered before by practical growers. Soil that had been heated, *e.g.* by a bonfire, or treated with the antiseptic (carbon disulphide) used for destroying certain pests, gave larger crops than before. The fact had even been reported to one or two of the German experiment stations, but it had not attracted very much attention. One important discovery had been made, however: it was found that partial sterilisation caused increases in the numbers of bacteria, and this was explained by supposing that the weaker races had been killed, leaving the more vigorous in clear possession of the field.

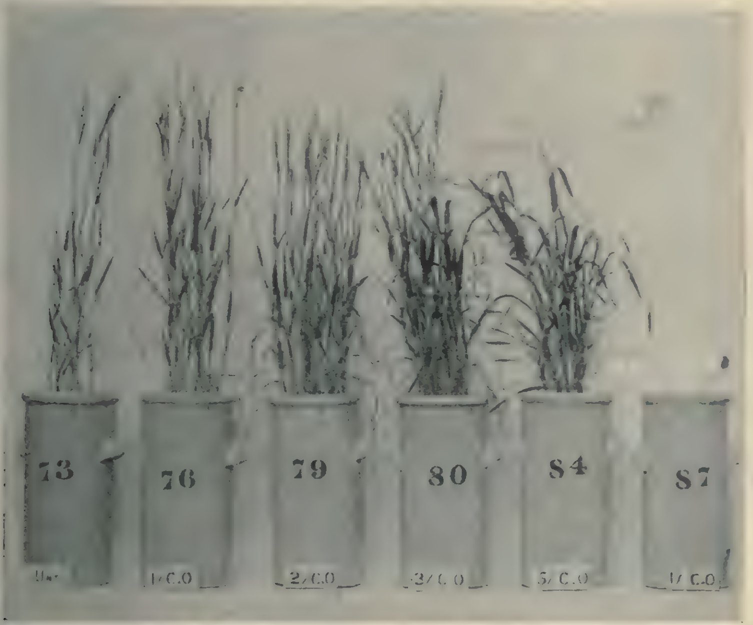


FIG. 2.—Lime as an agent for soil sterilisation. Pot 73, control; 76–87, successively increasing doses; between 79 and 80 lies the partial sterilisation point; 87 contains an excessive amount. (H. B. Hutchinson.)

Systematic investigations at Rothamsted soon showed that the increased productiveness of partially sterilised soils was due to an increased formation of ammonia, and this in turn was traced to the increased numbers of bacteria. The new flora, however, was not composed of more vigorous races as had been supposed; on the contrary, it was less vigorous than the old, and it owed its extra decomposing power to its numerical superiority. This point was established by numerous experiments because of its great importance in explaining the phenomena. The reason for the increased bacterial numbers was traced to a detrimental factor present in normal soils and keeping down the bacterial numbers; this factor was put out of action by partial sterilisation, whereupon the bacterial numbers began to rise. Owing to its highly complex nature soil forms very unpromising material for a direct attack; investigations have nearly always to be indirect. In the present instance the method adopted for discovering the detrimental factor was to ascertain what agencies put it out of action and what did not, and thus to draw up a list of its properties. It was found, for example, that the detrimental factor was sharply put out of action by heating to 55° C., or by any poison, and that it never set up again so long as the soil was kept free from dust; it did, however, appear when a little untreated soil was added, but the reappearance was slow and somewhat erratic. These and other experiments all indicated that the factor was biological; but definite evidence was obtained that it was not bacterial. Suspicion therefore fell on the protozoa, which were found to occur in all the natural soils examined but to be killed by the partial sterilisation. A very large number of experiments showed that the destruction of the soil protozoa always went hand in hand with the increase in bacterial numbers; up to the present no exception has been found. This is strong presumptive evidence, but unexpected difficulties arose when attempts were made to clinch the evidence by inoculating mass cultures of protozoa into partially sterilised soils, and up to the present these have not been overcome. We are, therefore, thrown back on indirect methods.

The first difficulty that was raised against the identification of the detrimental factor with the soil protozoa was that the protozoa were probably present in the soil as cysts, and not in the trophic state. It was argued that the soil conditions must be unfavourable for the development of animals like protozoa, which stand in constant need of air and water. The first investigations seemed to support this view. The copious development of protozoa when untreated soil is inoculated into hay infusion, of course, proves nothing; and when attempts are made to entice anything out of the soil by thermo- or galvanotactic methods nothing happened. The test organism was *Colpoda cucullus*, a ciliate occurring abundantly in the culture and easy to pick out under the microscope, and no evidence could be obtained that it occurred in the trophic state in the soil.

However, the experiments were continued. Mr. Martin found that a film was formed when soil was vigorously shaken with concentrated picric acid solution which, on examination, was seen to contain protozoa. The significance of the observation is, of course, that the acid instantly kills the organisms in the soil, so that the state in which they are found in the film is the state in which they actually occur in the soil. It was with no little interest, therefore, that the work of the protozoologists was watched, and when they discovered that the amœbæ were in the trophic state, and not all present as cysts, it was felt that a distinct advance had been made. Mr. Lewin has since devised a method of getting the protozoa alive out of the soil. Thus, satisfactory proof is furnished that an active protozoan fauna exists in normal field soils. Some of the organisms are of special zoological interest, and have therefore been studied in detail.

Even yet, however, the problem is not solved, because there is nothing to show how numerous the active protozoa are. Neither Martin's nor Lewin's method is susceptible of quantitative use, and at present the only guide is the ease with which the organisms can be picked out.

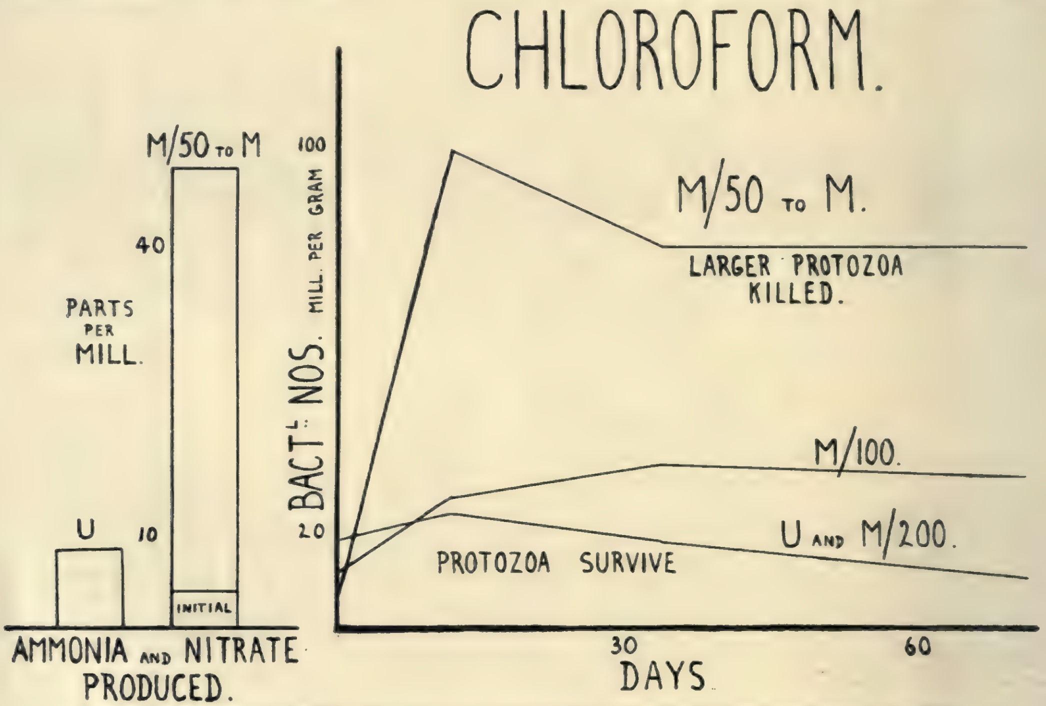


FIG. 3.—Effect of a typical volatile antiseptic on bacterial numbers and production of ammonia in soils. (Buddin.)

It was found from the soil investigations that the detrimental factor increased in intensity when the soil was kept moist, warm, and well supplied with organic matter. In these circumstances the bacteria might reasonably have been expected to increase enormously; as a matter of fact, they did not. Moreover, the fertility of these soils did not increase as much as was anticipated; it became less, and after a time no longer justified the cost of intense cultivation: this fact is well known among nurserymen, who speak of such soils as "sick." The treatment in the past has been to throw the soils out in despair, and to sacrifice the great manurial residues they contain. But it was obvious that the proper course was to adopt partial sterilisation methods; and laboratory and pot culture experiments alike proved the success of the method. For the moment, however, the main interest of the "sick" soils, *i.e.*, the soils known to be heavily stocked with the detrimental factor, is that they contain numerous active amœbæ, and never fail to give good crops of organisms by either of the methods in use.

On the other hand, the detrimental factor is reduced considerably by drying the soil, especially at high summer temperature. So also the harvest of protozoa becomes very thin in field soils during dry summer weather.

This, therefore, is the present position so far as the identification of the detrimental factor is concerned. There seems no doubt that it is living, and there is strong indirect evidence to connect it with the soil protozoa. But the direct evidence is lacking, partly because the difficulties of introducing mass cultures into partially sterilised soils have not yet been overcome, and partly because no satisfactory method of enumerating active protozoa in the soil has yet been devised. The zoological work is being continued: it has already more than justified itself by revealing the presence in natural soil of a trophic protozoan fauna the members of which are of considerable interest: the most important further development will be to ascertain whether the present indications are correct that the fauna is most numerous when the detrimental factor is most fully developed, and least numerous when the factor is not much in evidence.

The "sick" soils mentioned above are so important from the technical point of view that they have been further investigated. Sickness is proved to be an excessive development of the detrimental factor and also of disease organisms. The demonstration that it could be cured by partial sterilisation aroused much interest among nurserymen and growers who forthwith arranged to have trials made in their own glasshouses. The first efforts were, of course, crude; methods that work satisfactorily in a laboratory with a few kilos of material have a way of breaking down hopelessly when it comes to handling hundreds of tons in a commercial nursery. But the second season saw a great improvement, and the third an even greater, while perhaps the most satisfactory result of all is that the growers have collected 2500*l.*, half among themselves and half from the Development Fund, wherewith to build an experiment station to attack the special problems of their industry, and they have also obtained for it an income of some 900*l.* a year for the working expenses.

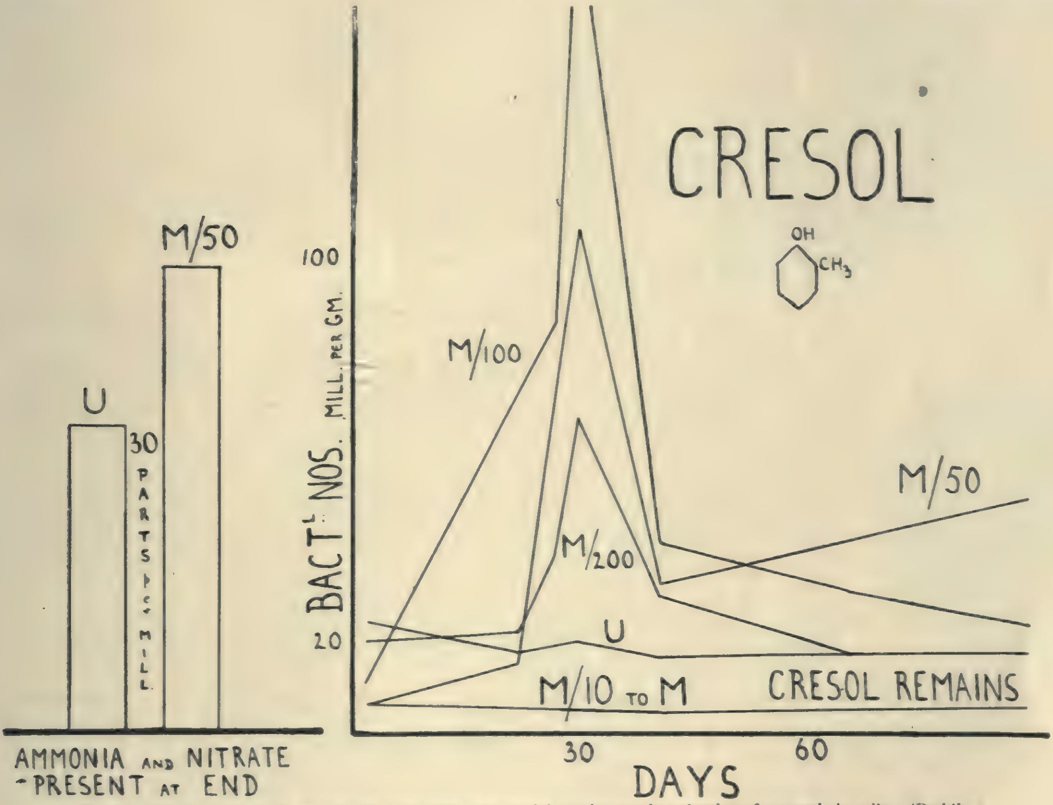


FIG. 4.—Effect of a typical non-volatile antiseptic on bacterial numbers and production of ammonia in soils. (Buddin.)

At present nurserymen use steam, but this would not be applicable for ordinary field work. The volatile antiseptics which work so well in the laboratory have also proved ineffective, even if the difficulties of application could be overcome. Search has therefore been made among solid and non-volatile liquid antiseptics. Lime was investigated by Dr. Hutchinson and found to answer satisfactorily; small doses are absorbed by the soil, but after a certain saturation point is reached the excess remains free and partially sterilises. All the usual phenomena turn up together, and the point indicated by the chemical tests is found to agree closely with that found by bacteriological and plant-growth tests (Fig. 2). Mr. Buddin has tried a wider range of substances, and finds a fundamental distinction between volatile and non-volatile organic antiseptics, illustrated in Figs. 3 and 4. Volatile compounds partially sterilise and then disappear, leaving no traces behind them: the effect on the soil depends solely on the germicidal potency of the substance. Non-volatile compounds, on the other hand, remain in the soil and react both on the organisms and the plant, but their action on the bacteria is peculiar. So long as the doses are not too strong, some of the soil bacteria flourish and multiply to an astonishing degree, apparently feeding on the antiseptic: phenol, cresol, hydroquinone, quinone, are all among the unpromising substances that produce this effect. The phenomena are quite distinct from those observed with volatile antiseptics; the rise in bacterial numbers is much higher, but it is not sustained; there is no sharp connection between the bacterial increase and the death of the protozoa, and the increased bacterial numbers do not produce any corresponding increase in ammonia or nitrate. Hence these non-volatile organic substances do not appear very promising, and for the moment steam remains the best agent: it partially sterilises; it effects some decomposition of the soil organic matter, and so lightens the subsequent work of the bacteria; and it produces some substances which induce a remarkable development of fibrous root. Experiments are still in hand, and we hope eventually to learn sufficient about these effects to be able to reproduce them in a way applicable to field conditions.

E. J. RUSSELL.

THE FAR-NORTH AUSTRALIAN.[1]

THE three volumes of studies of the natives of Central Australia which were published by Prof. Baldwin Spencer and the late Mr. F. J. Gillen, required for their completion some account of the natives of that portion of the continent which stretches northward to the shores of the Arafura Sea. This natural sequel, an account of the people of the Northern Territory, is to be found in the new and valuable record, dedicated to the memory of his dead colleague, which has just been written by Prof. Spencer. With the experience gained in his previous investigations, the author has produced an excellent volume, which is in every way equal to its forerunners in anthropological interest, in scientific value, and in clear description of another group of the totally uncivilised tribes of Australia.

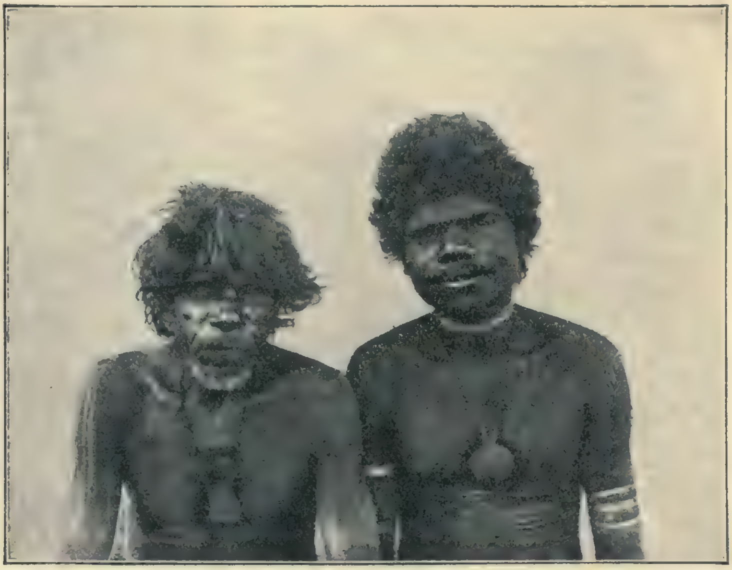


FIG. 1.—Two Kakadu Men. From "Native Tribes of the Northern Territory of Australia."

The introductory chapter, aided by nearly thirty pictures, gives a particularly vivid description of the country occupied by the tribes, their appearance and dwellings, general way of living, character and mental ability. A map shows the location of the tribes, those dealt with in most detail being resident on Melville and Bathurst Islands, on the mainland about Port Essington, the Alligator Rivers and Port Darwin, and southward to the region between Victoria River on the west and Roper River on the east. The total population is estimated at about 50,000.

The social organisation most prevalent in this region was found to differ from that usual in other parts of Australia. Instead of the class organisation, in which the tribe is divided into two main divisions, each with its subdivisions regulating marriage, and with descent either in the male or female line, many of the northern tribes follow a local organisation. The people are divided into a series of local groups, each owning and occupying a special district, and on marriage a man of one group takes his wife from another, and brings her and his children into his own group. The details of the various systems are fully given by Prof. Spencer, with tables of relationship terms in a series of typical tribes, and also the status terms applied to individuals at different periods of life.

With respect to the initiation ceremonies, the author divides the northern people into three groups. The first, occupying the islands, Coburg peninsula, and adjacent mainland, practise neither circumcision nor subincision. Adjacent tribes on the south practise circumcision only, whilst others inland from the coastal ranges and towards the centre of the continent practise both circumcision and subincision.

There is much variation in the totemic systems of the tribes. Where there is class organisation the totem groups are variously divided. Exogamy, though usual, is not always strict. Where the local organisation prevails, though there may be some marriage restrictions, there is sometimes no question of descent involved, and a child's totem is revealed to the father in a dream. The totems in all the tribes are usually edible articles, animal or vegetable, but in some cases implements and natural objects are totems. In many of the tribes a man may not eat his totem, but in others,

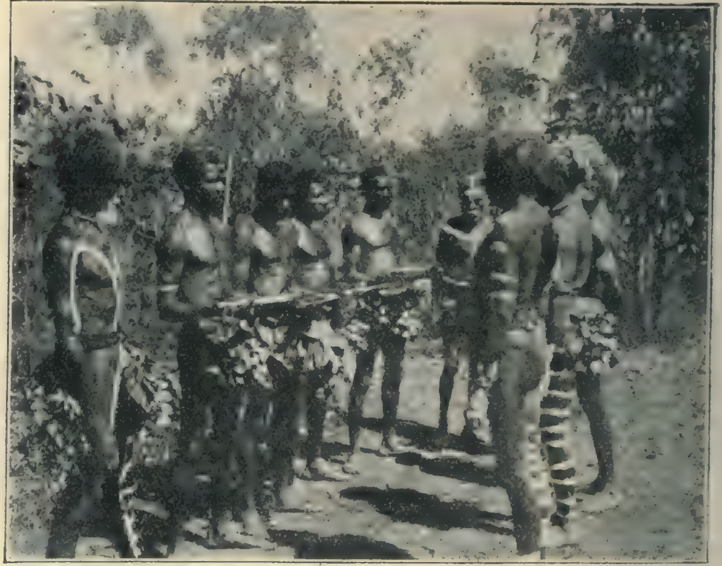


FIG. 2.—Placing the Bull-roarer on the hands of the Initiates, Larakia Tribe. From "Native Tribes of the Northern Territory of Australia."

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[1] "Native Tribes of the Northern Territory of Australia." By Prof. Baldwin Spencer. Pp. xx+516. (London: Macmillan and Co., Ltd., 1914) Price 21s. net.

though he may not capture or gather it, he may eat it if it be given to him by a man of another group. For the purpose of increasing the supply of the totemic animal or plant, certain magical ceremonies are performed. The bull-roarer and other sacred objects so prominent in the central region was not found among the tribes of the islands, the Coburg peninsula, and coast southward. The Kakadu (Alligator River) call the bull-roarer *kumali* and the Larakia (Port Darwin) *bidubidu*. The ceremonies in which they are used, and the traditions regarding them, are described by Prof. Spencer. Burial and mourning ceremonies vary greatly. The Melville islanders bury their dead in graves with elaborately ornamented grave-posts. The Kakadu of Alligator River also bury in the ground, but other tribes place the body in a tree. The Larakia follow tree-burial by burial in the earth or in holes in rocks. The Mara tribe eat their dead, and after exposing the bones on a tree platform, bury all but the long bones of the arm.

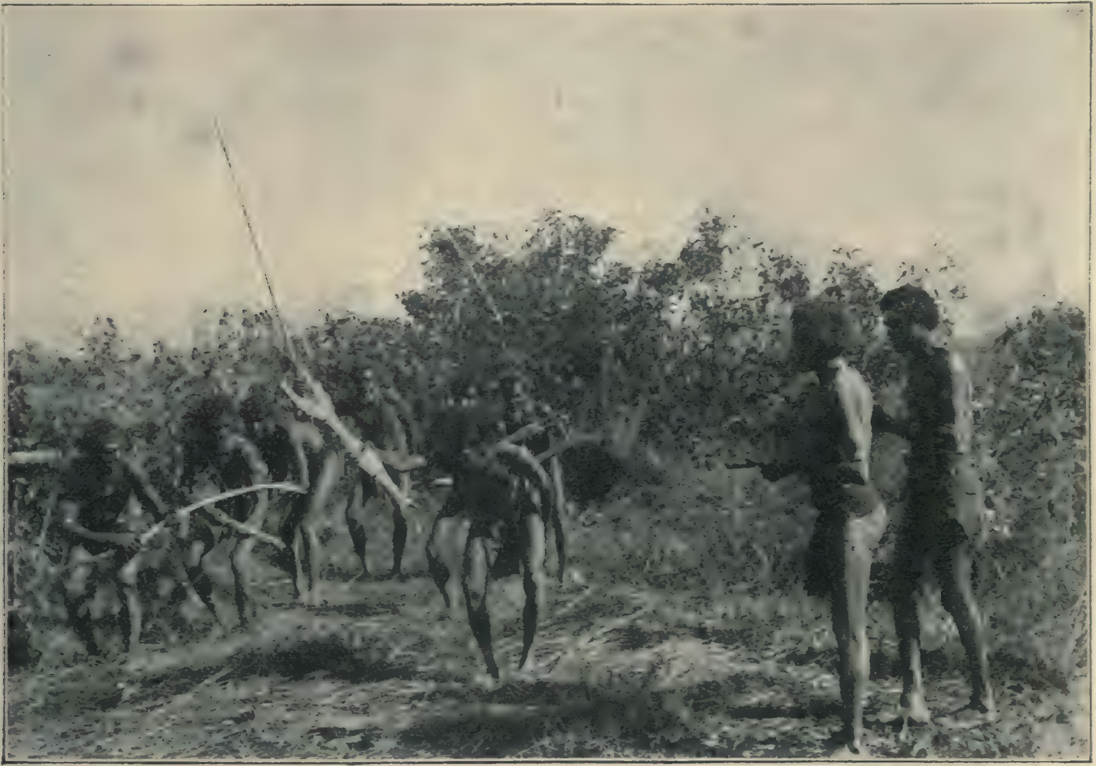

Fig. 3.—Scene from the Muraian Ceremony, Kakadu Tribe. From "Native Tribes of the Northern Territory of Australia.

An interesting account is given of magic and medicine. Evil is wrought by burning excrement. This entices away a man's protecting spirit, and so renders him liable to accident or hunger. The same practice will give a strong man's power to a youth. Maleficent magic is also wrought with a fragment of the victim's food, or with mud scraped from his foot. Disease is cured by eating pounded ant-hill.

The author discusses the curious belief as to the origin of children which, as in Central Australia, is found also among the northern tribes. The far-off ancestors, as they travelled about, shook off spirit children into caves and trees. These enter the women at these places and are born as natives. The dead go back to their old home, and after a time are born again, the sex being changed at each new birth. Half-castes are the result of eating the white man's flour.

Two extremely interesting chapters are devoted to traditions and legends. Food restrictions are also dealt with. They show the natives specially hampered by definite rules of eating during child-bearing and youth, age being privileged.

Separate chapters describe the weapons and implements, clothing and ornaments, and decorative art, the latter including rock and bark drawings. The illustrations to these chapters, some coloured, show these northern natives to be more advanced artistically than other Australians.

There is no suggestion of Malay influence in the region, and the author gives reasons against its possibility. The valuable linguistic appendix, mainly relating to three tribes, shows the languages to be characteristically Australian.

A few inconsistencies and omissions may be noted. The Umbia and Bingongina of p. 483 appear as Umbaia (p. 7, 17), Binbinga (p. 7). The organisation of the Maluuru tribe is given (p. 56), but there is no indication of its locale or that of the Allana tribe (p. 483). The use of Austral-English appears in the use of such words as: goanna, sugar-bag, lubra, pitchi, wurley, miamia, billy, billabong, tuck-out, and tucker.

Special features of the volume are the number and quality of the illustrations. There is a good index.

The work is an exceedingly valuable contribution to anthropological literature, indispensable for the student of primitive beliefs and ceremonial.

SIDNEY H. RAY.

THE EVOLUTION OF THE PETROGRAPHICAL MICROSCOPE.

WHEN Henry Clifton Sorby laid the foundation of the science of microscopical petrology, in the year 1851, the instrumental means at his command were of the simplest kind; his microscope had attached to it two Nicol-prisms, one above the eye-piece and the other below the stage, the latter being capable of rotation, thus rendering it possible to study the sections of minerals in rocks by plane polarised light. Then, as is so often the case, necessity became "the mother of invention," and Sorby himself, as well as several of his followers, devised additions to their microscopes which converted them into more useful instruments for investigating the optical properties of minerals, as seen in thin sections of rocks. The designers of these improvements were, of course, dependent on the able makers of optical instruments for putting their suggestions into practical form.

In the year 1876 the late Prof. Rosenbusch, of Heidelberg, who had been led to the microscopical study of rocks by Heinrich Fischer, one of the earliest pioneers in this branch of research in Germany, described "a new microscope for mineralogical and petrological researches." The chief features in this microscope were an accurately graduated, revolving stage, with verniers, and a complex nose-piece enabling the objectives to be rapidly changed. About the same time MM. Fouqué and Michel Lévy—with the co-operation of M. Emile Bertrand—had also turned their attention to the improvement of this class of instruments. The eminent optical instrument-maker of Paris, M. A. Nachet, carrying out their designs, constructed a microscope which embodied many advantageous features for petrographical work. In this instrument the necessity for the troublesome centring arrangements, for keeping an object on the cross-wires of the field of view, is got rid of by dividing the tube into two portions moving independently, the upper section carrying the eye-piece, analyser, and some accessory apparatus, and the lower attached to the finely graduated revolving stage bearing the objectives; these latter are easily changed by moving in a slide with spring-catch. Another important addition to the instrument which we owe to the French petrologists is the series of converging lenses with a magnifying lens above, by which interference figures may be viewed in the thin sections of minerals in rock-slides. It is true that these interference figures are only partial ones, but by the aid of diagrams supplied by the authors of the method their interpretation is rendered possible.

Outside France, the Nachet instrument would not appear to have come into very general use, a fact which is perhaps accounted for by the rather cumbrous arrangements necessitated by the division of the tube. In this country an arrangement having the same object has been devised by Mr. A. B. Dick, and has found much favour with many petrologists. It consists in having the rotating, polarising and analysing prisms so connected that they can revolve together, while the stage is fixed. The forms of the ordinary and Dick types of petrographical microscope, as employed by the officers of the Geological Survey of Great Britain are illustrated in Figs. 1 and 2.

Still more recently the celebrated Russian crystallographer, Féderow, has devised a form of the mineralogical and petrographical microscope, in which the crystal or section to be examined is carried on a stage which is capable of movement and inclination at exactly measurable angles, by which means very important optical determinations may be made. Instruments constructed on Féderow's plan are made by the Société Genevoise pour la Construction d'Instruments de Physique et de Mécanique, 87 Victoria Street, London, S.W.

As a matter of course, all the improvements in the mechanical and optical arrangements in microscopes introduced during the last fifty years have been made available for the instruments constructed for mineralogical and petrographical work. With the addition of many pieces of accessory apparatus, such as sections and wedges cut in definite directions from the crystals of various minerals, stage goniometers, and special arrangements for stage-movement, the instruments of this class have now become, as will be seen from the figures, more and more complicated as the refinement of methods has increased.

Not less important than these elaborate instruments employed in research are the simpler forms used in elementary and advanced geological teaching, which must necessarily be produced at much smaller cost. There are also special petrographical microscopes made, which are adapted for projection purposes in lecture-theatres, for photographic work, for examining crystals and sections while being heated and cooled, and for studying the development of crystals in solutions and fused materials. Examples of many of the types of petrographical microscopes are exhibited in the Science Museum at South Kensington.

As a direct offspring of the petrographical microscope, we may refer to the instruments now so extensively employed in metallographical researches. In 1864 Sorby, while studying sections of meteorites, for the purpose of comparing them with terrestrial rocks, was led to examine the grains of nickel-iron in the "sporado-siderites," after they had been etched, by reflected light. It occurred to Sorby that the same method of study might with advantage be employed in the case of artificial irons and steels, and his residence at Sheffield enabled him to obtain the necessary materals for a research, which not only resulted in important discoveries by himself, but laid the foundation of the science of microscopic metallography, which has made such important advances in recent years.

Our illustrations are taken from the catalogue of Messrs. James Swift and Son, who in this country have been among the foremost in meeting the often difficult requirements of scientific men, by carrying out their suggestions with great practical knowledge and skill.

J. W. J.

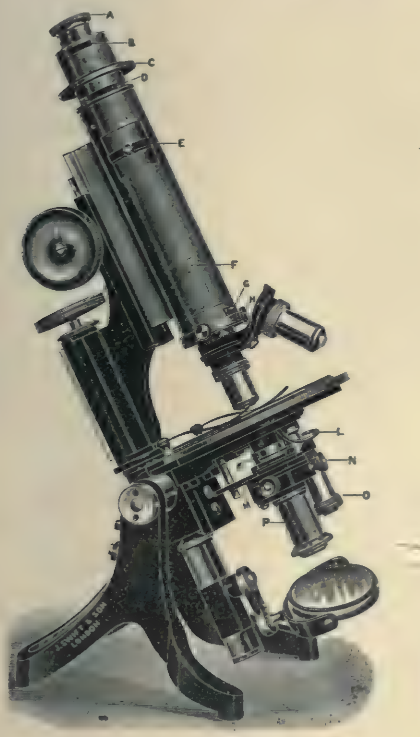

Fig. 1.—Swift's "Survey" Petrological Microscope. A, Rotating analyser working over ocular; B, slot for quartz wedge or other compensator; C, divided circle working in conjunction with analyser A; D slot through ocular for micrometer, etc.; E, slide carrying upper Bertrand lens which can be focussed and pushed out of the optic axis when not required; F, analyser in body, instantly removable from optic axis; G, slot for quartz wedge, etc., when working with analyser F; H, centring nosepiece; J, achromatic convergent system; K, iris diaphragm; L, loop for instantly removing top hemispherical lens of condenser; M, swing-out rotating cell for stops, compensators, etc.; N, centring screws to convergent system; O, focussing adjustment for convergent system; P, polariser mounted on independent swing-out arm.

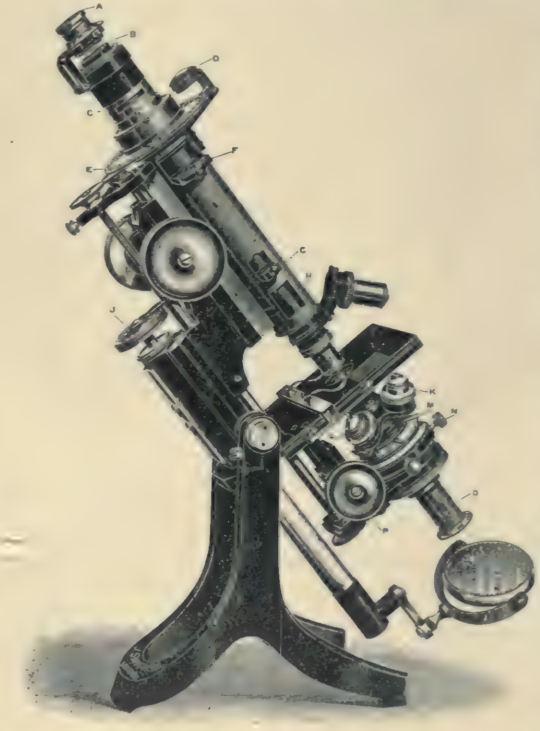

Fig. 2.—Swift's "Improved Dick" Petrological Microscope (Khartum model). A, Analyser mounted above ocular and geared to rotate simultaneously with the polariser; B, cross-webbed ocular; C, slot through ocular for wedges, micrometer, etc.; D, lens for reading circle and vernier; E, divided circle reading by vernier to 5′; F, slide bearing Bertrand lens (this lens is provided with a diaphragm of apertures and can be focussed and pushed out of the optic axis when not required); G, slide bearing lower Bertrand lens, Klein's quartz plate and a clear aperture (this lower Bertrand lens shows a much larger interference figure than the upper one, filling as it does the entire field of the ocular); H, extra analyser mounted in body (this analyser is generally used for photomicrography); J, fine adjustment by differential screw which by means of a vernier reads to 0·0002 mm.; K, aplanatic oil immersion condenser, n.a. 1·40; L, aplanatic dry condenser, n.a. 1·0; M, iris diaphragm below which is a rotating swing-out cell for stops, compensators, etc.; N, screws to centre condensers; O, polariser mounted on an independent swing-out arm; P, milled head for focussing condensers.

DR. M. C. COOKE.

BOTANISTS will learn with regret of the death of the veteran mycologist, Dr. M. C. Cooke, at Southsea on November 12. Mordecai Cubitt Cooke was born at Horning, Norfolk, on July 12, 1825. His early education was scanty, but he received help from his uncle, who instructed him in botany as well as in mathematics and languages. Some years later he became a lawyer's clerk, and afterwards a teacher under the old National School system, the economic value of food-plants being one of his teaching subjects. This led to his preparation of a catalogue for the Indian Department of the Exhibition of 1862, and eventually to work at the India Museum. Here he spent much time studying the lower cryptogams, especially fungi, on which he soon became a leading authority.

In 1880 Cooke obtained an appointment in the Herbarium of the Royal Botanic Gardens, Kew, being placed in charge of the Thallophyta, a post which he continued to hold until he retired at the age of sixty-five. Whilst at Kew he completely re-arranged the mycological collections, and incorporated the large and valuable herbarium of the Rev. M. J. Berkeley, and later on his own extensive collections, which have been estimated to number 46,000 specimens. He also dealt with material coming in from abroad, from which he described and figured many new species. During this period he was assisted in his private work by Mr. George Massee, who afterwards succeeded him in his duties in the Cryptogamic Department.

Cooke stands out as a great systematic mycologist, and as a populariser of his science. His first important work—"Handbook of British Fungi"—(1871) is a classic, which to this day demands a good price. The most celebrated is "Illustrations of British Fungi." These eight volumes, containing 1200 plates of British Agaricaceæ, are a stand-by of all British mycologists, and the fact that they are still the subject of scrutiny and criticism by eminent continental botanists only testifies to their importance in mycological literature. For twenty years Cooke edited *Grevillea*, a journal devoted to

Cryptogamic botany. He also published a fungus flora of Australia and many papers of scientific importance, besides innumerable minor articles. His industry is further attested by the presence in the Kew collections of about 25,000 of his drawings of fungi. During later years, especially, he wrote popular books, and also turned his attention to other fields of cryptogamic botany.

After his retirement in 1892 Cooke retained his interest in fungi, and until 1904 attended the annual fungus foray of the Essex Field Club. Recently his eyesight failed, though his mind remained keen and active. He was honorary M.A. of Yale, and LL.D., and in 1903 he had the honour of being awarded the gold medal of the Linnean Society. A. D. C.

NOTES.

THE King has been pleased to approve of the following awards this year by the president and council of the Royal Society:—A Royal medal to Prof. E. W. Brown, F.R.S., for his investigations in astronomy, chiefly in lunar theory; a Royal medal to Prof. W. J. Sollas, F.R.S., for his researches in palæontology, especially in the development of new methods. The following awards have also been made by the president and council:—The Copley medal to Sir Joseph Thomson, O.M., F.R.S., for his discoveries in physical science; the Rumford medal to the Rt. Hon. the Lord Rayleigh, O.M., F.R.S., for his numerous researches in optics; the Davy medal to Prof. W. J. Pope, F.R.S., for his researches on stereochemistry and on the relations between crystalline form and chemical constitution; the Darwin medal to Prof. E. B. Poulton, F.R.S., for his researches in heredity; the Hughes medal to Prof. J. S. Townsend, F.R.S., for his researches on electric behaviour of gases.

NATIONAL regret at the death of Lord Roberts on Saturday last, as the result of a chill caught while on a visit to France to see the Indian troops, is shared by men of science. Throughout his career Lord Roberts stood for scientific organisation and individual efficiency; and to the last day of his life he was concerned with undertaking useful services for his country. In the field his success was the fruit of careful forethought, boldness, and vigour; when an administrator he laid stress on the encouragement of intelligence and initiative among soldiers of all ranks; and after his retirement from active service he devoted the remainder of his days to advocating the encouragement of rifle shooting as a national pursuit, and the establishment of a system of obligatory physical training. He saw the needs of his country and did his best to educate public opinion in favour of a remedy for them. In Lord Roberts the attributes of duty and self-sacrifice were represented at their highest, and the whole Empire mourns that he has now passed into silence.

THE council of the Physical Society of London has decided not to hold the annual exhibition of physical apparatus this year.

THE eighty-ninth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Prof. C. V. Boys, his title being "Science in the Home."

WE regret to learn of the death, at sixty-five years of age, of Dr. J. Borgmann, professor of physics in the University of Petrograd, and author of various works on electricity and magnetism.

WE regret to announce that Prof. August Weismann, professor of zoology in the University of Freiburg-im-Breisgau since 1867, foreign member of the Royal Society, and of world-wide distinction as a biologist, died on November 5 at eighty years of age.

AT the annual meeting of the London Mathematical Society, held on November 12, the De Morgan medal was presented to Sir Joseph Larmor in recognition of his researches in mathematics and mathematical physics.

A FAIRLY strong earthquake was felt over Jamaica on October 15 (see NATURE, vol. xciv., p. 207). A month later, on November 15, two other shocks were felt, the first at 12.50 a.m., of considerable force, and lasting seven or eight seconds; the second, a slighter shock, between 8 and 9 a.m. No serious damage was caused by either shock.

MR. W. S. ADAMS, Mount Wilson Solar Observatory, California; Prof. H. Andoyer, professor of physical astronomy in the Sorbonne, Paris; and Dr. F. Schlesinger, director of the Allegheny Observatory, and professor of astronomy, University of Pittsburgh, U.S.A., have been elected associates of the Royal Astronomical Society.

IT is announced in the *London Gazette* that the King has appointed Mr. T. H. Warren, president of Magdalen College, Oxford, to be Knight Commander of the Royal Victorian Order, and Mr. C. G. Robertson, fellow of All Souls' College, and senior tutor in modern history at Magdalen College, Oxford, to be Commander.

FOR several years Prof. W. B. Bottomley, King's College, London, has been working on the bacterial treatment of peat; and some results of the investigation have been described in papers presented to the Royal Society and the British Association. The Board of Agriculture has now made a grant of 150*l.* to the botanical department of King's College in aid of research on the subject of the probable accessory food-substances in humus and "bacterised" peat, a condition of the grant being "that reasonable facilities will be accorded to any accredited scientific worker who may desire to undertake investigations in connection with 'bacterised' peat."

AT the anniversary meeting of the Mineralogical Society, held on November 10, the following officers and members of council were elected:—*President*: Dr. A. E. H. Tutton. *Vice-Presidents*: Prof. H. L. Bowman and Dr. A. Hutchinson. *Treasurer*: Sir William P. Beale, Bart. *General Secretary*: Dr. G. T. Prior. *Foreign Secretary*: Prof. W. W. Watts. *Editor of the Journal*: Mr. L. J. Spencer. *Ordinary Members of Council*: Mr. F. H. Butler, Mr. J. P. De Castro, Mr. B. Kitto, Prof. A. Liversidge, Dr. J. J. Harris

Teall, Mr. F. N. Ashcroft, Prof. H. Hilton, Mr. A. Russell, Mr. W. Campbell Smith, Dr. J. W. Evans, Dr. F. H. Hatch, and Mr. J. A. Howe.

At a meeting of the council of the British Association, held on November 6, it was resolved:—"That the council of the British Association for the Advancement of Science, at its first meeting in London since the return of members from Australia, desires to place on record its high appreciation of the generous reception given to the members of the overseas party throughout the Commonwealth by representatives of the Governments of the Commonwealth and the States, and by other authorities and Australian citizens generally, on the occasion of the meeting of the association in Australia in 1914. The council hereby expresses its grateful thanks for the hospitality, privileges, and concessions extended so freely to visiting members, and also for the willing and valuable collaboration of all those who undertook so successfully the work of organisation in Australia in connection with the meeting."

By the death of Sir Walter Gilbey at Elsenham Hall, his Essex residence, on November 12, the country is distinctly the poorer, as the deceased baronet had an unsurpassed practical knowledge of horses and horse-breeding, more especially as regards "shires," hackneys, and ponies. His two little books on these breeds are models of what such works should be, teeming, as they are, with practical and historical information condensed into the briefest possible space. Sir Walter was the founder of the Shire Horse Society, which published its first stud-book in 1880, and held its first show at the Agricultural Hall in 1881. He also took an active part in the establishment of both the Hackney Horse Society and the Hunters' Improvement Society, and he was likewise instrumental in diverting the grants for "Queen's Plates" to the more useful purpose of premiums for thoroughbred sires. He was in turn president of both the Shire Horse and the Hunters' Improvement Society. It may be added that Sir Walter did no less good service for stock-breeding and agriculture in general. He had attained the ripe age of eighty-three years.

America has lost one of her leading geographers by the death, in his sixty-ninth year, of Mr. Henry Gannett. After graduating at the Harvard Scientific and Mining Schools, he was for a short time an assistant at the Harvard Observatory. From 1872 to 1879 he acted as topographer for the Hayden Survey of the Territories. When the U.S. Bureau of Geological Survey was established in 1879, Mr. Gannett assisted in planning out its work, and from 1882 until his death he held the position of its chief geographer. He was geographer to three decennial censuses and to the Conservation Commission of 1908–9, chairman of the U.S. Geographical Board, and president of the National Geographic Society. His published works included gazetteers of twelve States, the statistical atlases of three censuses, the contour map of the United States, a manual of topographic surveying, and numerous official reports. In an editorial note on his career the New York *Evening Post* pays him the tribute that, in spite of the notable results of his own industry, it is as a stimulator of other geographers and map-makers that he chiefly deserves to be remembered.

We are glad to see again the familiar pages of the *Revue Scientifique*, the publication of which was suspended at the beginning of August, on account of the war. The number which has just reached us is the first to be published since August 1, and it bears the date August 8–November 14. The main part of the issue is made up of the papers upon the nature and treatment of wounds, presented to the Paris Academy of Sciences on August 10 and September 28, and referred to already in our columns. Following these is a translation of the statement signed by German professors as to the cause of the war, with a complete list of signatures, and replies to the manifesto made by the Academy of Sciences, the French Academy, Institute of France, representatives of Russian art, literature, and science, and British scholars. Sir William Ramsay's article on "Germany's Aims and Ambitions" is translated from Nature of October 8, and there is also a translation of the letter from Dr. C. W. Eliot, president of Harvard University, published in the *New York Times* of October 2. We trust that our contemporary will find it possible to continue its weekly issue as formerly. *La Nature*, which suspended publication on August 1, has not yet started a re-issue.

Accounts of the valuable work which the officers of the Royal Army Medical Corps have accomplished in Boulogne for our wounded are given in the *Times* of November 10 and 14. The description of the Boulogne hospitals affords a clear picture of the very best sort of hospital administration and practice, thanks to Colonel Lynden Bell, Sir Almroth Wright, and all members of the staff and nursing staff of each hospital. From the potent and unfamiliar infections of the Belgian soil, which has been under intensive cultivation and incessant manuring for a quarter of a century, comes a host of troubles. The majority of the wounds are contaminated at the moment of infliction. The usual ritual of the antiseptic and aseptic method, perfect in time of peace for this or that formal operation of surgery in a placid, well-appointed hospital, may not suffice for the treatment of men wounded in the trenches by shrapnel or shell fragments, their clothes and their skins caked thick with mud, and that mud carrying dangers of its own. Against the risk of tetanus, we have the protective use of the tetanus antitoxin; against gangrene, we have the injections of oxygenated water, and the later "open-air" treatment of the wound, and there are other methods by which science is used to reduce suffering at the Boulogne hospital base and elsewhere.

In *Man* for November, Prof. Carveth Read examines the question of the differentiation of man from the anthropoids. He dwells on the importance of the change from a vegetable to a carnivorous diet on the habits, functions, and structure which distinguish man from the higher apes. This change of diet, he urges, explains the adaptation of our species to a ground-life and to a world-wide diffusion. This involves social co-operation, the growth of articulate speech, the invention of weapons, and the discovery of the use of fire. Again, it involves the growth of the erect gait and of other modifications in the bodily structure. He urges that if this hypothesis be not accepted, man is an exception to the rule of animal life—that the structure of every organism is made up of apparatus subserving its special conditions of nutrition and reproduction.

With part viii. of his useful periodical, *Visvakarma* Mr. A. K. Coomaraswamy has for the present suspended its publication. The work contains one hundred examples of Indian architecture, sculpture, painting, and handicrafts. Mr. Eric Gill supplies a rather flamboyant introduction. The nineteenth century, he tells us, "for all its hard-headedness, was soft-hearted and loose-thinking." The newly awakened interest in Oriental art is, he thinks, "a genuine reaction against the irreligious gentility and banality of modern European art." There is some excuse for this acrid criticism, and *Visvakarma* helps to show that the art of India has much to interest the European student. But the cause of Oriental art will scarcely be promoted by disparagement of the aims and methods of European artists.

Messrs. C. A. Hall and Duncan Smith have reprinted from the Transactions of the Paisley Philosophical Institution, 1914, a paper dealing with the geological and historical significance of some hazel nuts and other plant remains discovered during excavations at Paisley Abbey in March, 1914. These remains rested on the gravel of an ancient sea-beach, which is believed to be the 25-ft. raised beach, a pronounced feature in various parts of the Clyde area. This, after attaining its maximum elevation, was depressed and submerged. When hazel trees grew in this area it was some 25 ft. lower than it is at present. The writers, associating Neolithic man with the 25-ft. raised beach period, urge that their investigation forms a fresh link in the chain of evidence by which the age of Neolithic man may be determined.

A class in mineralogy, with free access to a representative series of specimens, is the latest development of the Children's Museum, Bedford Park, Brooklyn. The collection of minerals, according to the November number of the *Children's Museum News*, has also been rearranged and expanded, economic uses being the basis of classification.

"The Middle Triassic Marine Invertebrate Faunas of North America" is the title of a very fully illustrated memoir by Prof. J. Perrin Smith, published in Washington by the Department of the Interior (U.S. Geological Survey) as Professional Paper No. 83. It deals chiefly with cephalopods, especially ceratites and other ammonoid groups, 142 out of the 148 pages of letterpress being devoted to that class. In Triassic times the sea, which had previously covered large portions of the area now occupied by the North American continent, had retreated westwards until it formed only a gulf in the region of the Great Basin. The most remarkable feature of the fauna of the Middle Triassic beds of this tract is its complete lack of relationship to that of Japan, and its marked affinity to that of south-eastern Europe. It is, in fact, of "such a distinctly Mediterranean character that if a palæontologist from Austria were set down in the Triassic area of the Humboldt desert he could hardly tell from the character of the fauna whether he was collecting in Bosnia or in Nevada."

Prof. Perrin Smith's work on the Triassic ammonoids referred to in the preceding paragraph was doubtless the forerunner of a paper on accelerated development in fossil cephalopods, issued in the Leland Stanford Junior University Publications, University Series, for 1914. To do justice to this thoughtful communication would take much more space than is at our disposal; and it must suffice to state that, owing to the compression of the earlier stages, a large number of groups do not exhibit a recapitulation of their ontogenetic history. There is, in fact, a constant loss of stages or characters, which become pushed back and finally crowded out of the ontogeny, all along the race-history, so that successive types do not exhibit their full genealogical story. In addition is "convergence," which, in ammonites, has rendered a number of types descended from perfectly distinct ancestors so alike as totally to defy recognition of their genealogy.

Mr. Frederick Chapman provides a comprehensive review of the Cainozoic strata of Australia in the fifth memoir of the National Museum, Melbourne (July, 1914). He shows that the supposed nummulites of Australia should be referred to Amphistegina, and regards the earliest beds of what he calls "the Australian Cainozoic system" as of Oligocene age. The correlation of the strata with those of Europe, and the description of typical sections, make this paper especially welcome.

The inspiring story of the rise and progress of the Scottish school of geology was selected by Prof. T. J. Jehu as the subject of his inaugural lecture as Murchison professor of geology and mineralogy in the University of Edinburgh. Due stress was laid in this discourse on the influence of Sir Andrew Ramsay, T. F. Jameson, Sir Arch. Geikie, also Prof. J. Geikie and other Scottish workers, in promoting a just appreciation of glacial phenomena in our islands.

Prof. Gürich, of Hamburg, has published (Borntraeger, Berlin, price 5.50 marks) an illustrated account of "Die geologischen Naturdenkmäler des Riesengebirges," which forms a scientific guide to a region of granite tors and ice-worn hollows which has been little visited by strangers. The fine view of the Schistose Schneekoppe (1605 miles) reminds us of our own highlands, where the cirques are becoming modified by downwash and general decay. A block of orbicular granite is figured, which is probably of local origin. This, like other natural monuments in the district, has been put under special guardianship.

One of the most interesting and readable memoirs issued in the Clare Island Survey series is by T. Hallissy on the geology of the island (Proc. Royal

Irish Academy, vol. xxxi., part 7, price 1s. 6d.). Reference is made for further details to the memoir recently published by the Geological Survey of Ireland; but the present account shows especially how the district was influenced by the ice of glacial times, and an excellent series of illustrations has been included, most of which were hitherto unpublished. The map of Clew Bay and its numerous partially-drowned drumlins will interest those who have entered Boston harbour from the sea. The large coloured geological map is repeated, by arrangement with the Controller of the Stationery Office, from the Geological Survey memoir.

We have frequently taken occasion to refute some of the long-lived popular fallacies relating to the weather. The *Scientific American* of October 24 refers to a statement in a recent London weekly journal that "it is one of the extraordinary things of warfare that a big battle invariably produces rain." Our American contemporary has no difficulty in refuting the "particularly fatuous fallacy" that a battle could have any appreciable effect on the temperature or humidity of the air, upon which conditions rainfall depends. He points out that rainfall may follow battles for various reasons, *e.g.* meteorological records in northern France show an average of about 157 rain-days per annum, according to which rain might possibly fall about every other day. Recent literature upon the subject is abundant and conclusive; as one instance we may refer to an interesting and instructive article by Prof. Cleveland Abbe in the United States *Popular Science Monthly* of January, 1911, which shows by laboratory experiments that the firing of cannon or dynamite to produce rain cannot possibly succeed. We may also mention a pertinent communication to *Symons's Meteorological Magazine* of March, 1911, in which Mr. F. Gaster (formerly of the Meteorological Office) pointed out that at Shoeburyness, where great guns are fired almost daily, the average rainfall is probably the smallest in the United Kingdom.

The Committee of the Institution of Civil Engineers, which has been making inquiries as to the best course of training for engineers, mentions in its report that one firm considered technically trained men of "no use for dividend earning." Mr. F. M. Denton, in a letter in the *Electrician* of November 6, points out that this prejudice against technical college-trained men on the part of engineering firms has cost us very dearly in the past, much of our best trade, and more new trade we should have liked, having gone to our rivals. The hope of regaining and retaining this trade in the future is, he considers, elusive unless manufacturers are prepared to recognise that a technical training permits a man to see further than he would otherwise do, and that research carried out by such men has been responsible for practically all the advance in heavy electrical engineering in recent years. We cannot as a nation content ourselves with merely making and selling what others have developed, but must provide our own army of research, and lead instead of following.

In the *Comptes rendus* for November 3 M. G. Lippmann directs attention to the possibility of applying the Hughes induction balance to military surgery. This invention, it is remarked, appears to-day to be totally forgotten. It consists of a battery, two small induction coils, a contact-breaker, and a telephone, the connections being crossed in the primary circuit so that the induced electromotive forces are in contrary directions. The coils can then be adjusted so that no sound is heard in the telephone in the secondary circuit. On the approach of a metallic mass to one of the bobbins, a sound is heard in the telephone. If the metal is magnetic, as is the case with a fragment of shell or a German bullet, the effect is more marked; French and German bullets can in this way be distinguished. M. Lippmann thinks the apparatus should be useful in military surgery, as it is easily made in numbers, simple to use, portable, and cheap.

Aluminium is now employed to a greater or less extent in almost all engineering and allied trades, but it is doubtful if the full extent and variety of its applications are generally recognised. About 60,000 tons of the material are produced every year. *Engineering* for November 13 points out that there is no reason why the foundry of a general engineering shop should not produce aluminium castings in the same way that it now produces those of the copper alloys. Probably the reason for the neglected use of aluminium is that the average engineer is not practised in the manipulation of this metal. A quite definite case can be made out for the employment of aluminium for low-tension electric cables, particularly those of large section. There are a number of important installations in existence, *e.g.* the Paris General Omnibus Company has 650 tons of aluminium cables, yet on the whole the material does not occupy the position which might be expected. There is little doubt that in many cases copper cables are now being installed where important saving might be made by employing aluminium.

OUR ASTRONOMICAL COLUMN.

Comet 1914d (Lunt).—The comet discovered by Dr. Lunt at the Cape Observatory is travelling northward, and the elements and ephemeris (the *Observatory*, November) have been calculated by Drs. Hough and Halm, and these are as follows:—

Elements.

T = .914 August 4·91638 G.M.T.

$$\left.\begin{aligned}\omega &= 269^\circ\ 53{\cdot}6' \\ \text{☊} &= 0^\circ\ 22{\cdot}5' \\ i &= 77^\circ\ 53{\cdot}3'\end{aligned}\right\}\ 1914{\cdot}0$$

$\log q = 9{\cdot}85024$

Ephemeris for Greenwich Midnight.

		R.A. h.	m.	s.		Decl. °	′
Nov. 18	...	21	51	8	...	+8	27
22	...		53	20	...	9	13
26	...		55	41	...	9	56
30	...	21	58	21	...	10	38

It is stated that the corrections to the above on October 11 were −20s., +7′, and on October 17 −25s., +11′.

Series Lines in Spark Spectra.—In the issue of this journal for April 9 of the present year (vol. xciii., p. 145) a summary was given of the Bakerian lecture delivered by Prof. Fowler on April 2 on series lines in spark spectra. Attention is directed to the fact that this lecture is now published in the *Philisophical Transactions* of the Royal Society (Series A, vol. ccxiv., pp. 225–66), and is accompanied by some excellent reproductions from photographs of the spectrum of the magnesium arc *in vacuo*, the various series of arc and enhanced lines being clearly indicated.

A Brilliant Fireball.—Mr. W. F. Denning writes: "On November 11, at 11.13 p.m., a magnificent meteor was seen from near Purley, Surrey, Stowmarket, Hornsey, and other places. It looked like an unusually large ball from a Roman candle firework, and moved very slowly in the north-east sky, occupying about 6 sec. in an extended course. It was not a Leonid, but apparently from a radiant near α Lyræ in the north-west. The meteor illumined the sky vividly for several seconds, and was evidently rather near the earth's surface. From a preliminary discussion of the few descriptions already to hand it appears that the object fell from a height of fifty to thirty-two miles, and its velocity was about eleven miles a second. There is no known shower near Vega at the middle of November, but certain large meteors appear to be isolated. Some of the observers supposed it to have been one of the regular November meteors, but its direction was different and its speed altogether too slow for it to have been a Leonid."

Measured Parallaxes Summarised.—A reprint from the *Astronomische Nachrichten*, No. 4754, has been received, and it contains a communication on measured parallaxes summarised by Mr. O. R. Walkey. The author states that in view of the inherent uncertainty of all measured parallaxes, it does not seem profitable to enter into a detailed discussion of the individual results, but instead the results are summarised in a series of tables of distance and consequent luminosities and cross-motions speeds according to the spectral type. The tables given represent 521 stellar systems, not counting the sun. The first three tables do not include the Hyades group, which consists mainly of first-type stars; these are dealt with in a fourth table according to their component spectral classes. The investigation is one that is the result of a large amount of labour, and the essence of the work lies in the tables, which will no doubt be carefully scrutinised by those to whom the subject is of special interest.

Report of the Paris Observatory for 1913.—Like all other large observatories situated in or near towns, the work of the Paris Observatory is being severely handicapped by the presence of disadvantageous observing conditions such as smoke, night glare, etc. The report for the year 1913 gives a good idea of the great number of branches of work undertaken, but in the different summaries of the recent progress there is an underlying tone of regret that much cannot be done and much that is done is not as satisfactory as it might have been owing to the present observing conditions. Monsieur Baillaud, the director, opens his report with a reference to the deplorable conditions of the actual situation and to the indispensability of the creation of a branch establishment which he advocated two years ago. With regard to the meridian work, the north and south horizons have been shut out by seven-storey buildings, and he points out how the work of the equatorials is restricted by the haze and fog in the lower strata of the atmosphere of Paris. Comet Delavan was estimated as of the eleventh magnitude at Besançon, Bordeaux, and Lyon, while at Paris it appeared of magnitude 13. Regular photometric work, so important for the undertaking of the Carte du Ciel, is described as impossible, and in the astrophysical department the quality of the stellar images projected on the slit exercises unfortunately a very great influence on the determinations of radial velocity. Numerous other references to other branches of work effected are given, making a clear case for the necessity for an out-station. For the present, no steps can be taken, but it is hoped that in the near future Monsieur Baillaud's appeal will be considered and carried out. The annual report takes the same form as in previous years, and the work of the several departments during the past year is described in the various sections.

THE FUNCTION OF THE EARTH IN RADIO-TELEGRAPHY.

A LECTURE on the above subject was delivered on Friday evening, November 13, by Dr. J. A. Fleming, to the members of the Wireless Society of London, at the Institution of Electrical Engineers. Dr. Fleming said that the present period of enforced inactivity for all loyal radio-telegraphists, except those engaged at the seat of war, offered an opportunity to re-consider some of the purely scientific questions involved in the art. He proposed therefore to discuss the function of the earth in radio-telegraphy. Apart from the disputed question whether the aerial wires should preferably be earthed at the base or connected to an insulated balancing capacity, it was well known that the nature of the soil or surface between the transmitting and receiving stations had a great effect on the signal strength. This effect depended much upon the wave-length. Thus Dr. L. W. Austin had shown that the ground to the north and north-east of Newport, Rhode Island, U.S.A., exercised a powerful absorption on radio-telegraphic waves of about 1000 metres wave-length. Experiments made between Brant Rock wireless station and a U.S. cruiser *Birmingham*, lying at Newport, showed that whereas electric waves of 3750 metres wave-length suffered little or no absorption in travelling over the 45 miles other than that due to the normal space decrease of energy, waves 1000 metres in length lost 95 per cent. of their signalling energy in passing over the same district.

Dr. Fleming first gave a brief mathematical discussion showing the manner in which the gradual penetration of an alternating current into a conductor can be explained. It is well known that high frequency electric currents are confined to a thin skin or layer of the surface of metallic wires. In the case of copper this skin has a thickness of about 0·25 mm. for currents of a frequency of one million. In the case of iron the skin for the same frequency is about 0·02 mm.

An elegant experiment was shown by Dr. Fleming with his cymometer to illustrate this surface flow of high-frequency currents. An oscillation circuit was arranged in which high-frequency currents were generated, and these were detected by placing alongside a cymometer having a Neon vacuum tube as a detector of secondary oscillations in its circuit. In the primary oscillation circuit were inserted successively small spirals of copper, brass, iron, and galvanised iron; all having the same size and same number of turns. The oscillations in the cymometer circuit were indicated by the brilliant glow of the Neon tube. When the iron spiral was inserted the Neon tube did not glow, because of the damping of the oscillations caused by the energy absorbed to magnetise the iron.

The galvanised iron spiral behaved, however, just like a copper or brass spiral, because the oscillations did not penetrate through the thin layer or skin of zinc into the iron. If, however, this zinc was oxidised or broken, then the iron core exerted its effect in damping the oscillations.

Dr. Fleming then explained that when a radiotelegraphic wave passes over the earth it penetrates to some extent into it, and also loses amplitude owing to the absorption of wave energy by the soil. The depth of penetration or depth in which the forces attenuate to $\bar{\epsilon}^{1}$ or to $0\cdot368$ of their surface value, and the horizontal attenuation or distance in which the surface values decrease to the same fraction of their original value can be calculated as shown by Dr. Zenneck when the values of the soil conductivity, soil dielectric constant, and frequency are known. Thus taking the generally accepted values for sea water for waves 1000 ft. in wave-length, the penetration into the sea is at most about one metre. In the ordinary dry soil it may be 100 or several hundred metres. There is a certain soil conductivity and wave-length which gives the maximum attenuation of the wave over a given distance.

The calculation of the depth of penetration and attenuation of the wave with distance can be made when this soil conductivity and dielectric constant is known. Recent researches have shown, however, that the conductivity of imperfect insulators for alternating currents is much greater than for direct currents. Dr. Fleming referred to researches by himself and Mr. Dyke for proof of this fact. Lately, he said, Mr. Bairsto had continued this work in his laboratory for currents of extra high frequency of one or more million, and found their dielectrics had a maximum conductivity for a certain high frequency. The inference from this was that the earth was an incomparably better conductor for the high frequency currents used in radio-telegraphy than for ordinary low frequency or steady currents. Dr. Fleming then went on to consider the propagation of an electric wave over the earth's surface, and pointed out that Sommerfeld had shown that when a Hertzian oscillator had one half connected to the earth there would not only be space waves through the dielectrics (air and earth), but a surface wave along the surface which would consist in longitudinal electric currents propagated as a wave motion along the surface. Dr. Fleming pointed out that this surface wave might be the explanation of the well-known facts that signals from long distance wireless telegraph stations can be picked up and detected without any high receiving wire, merely by connecting one end of the receiver to the earth and the other to any insulated mass of metal in the interior, it may be, of a house.

Passing then to the consideration of the diffraction of long electric waves round the earth, Dr. Fleming gave a brief account of the state of the theories advanced by Poincaré, Nicholson, Macdonald, and Rybczynski. These agreed that the amplitude of an electric wave sent out horizontally from any point on the earth's surface diminished according to an exponential function of the distance and wave-length. The last-named analyst had shown that this function was of the form $\epsilon^{-0\cdot0018r/\sqrt[3]{\lambda}}$ where r is the distance of the sending and receiving stations, and λ is the wave length. Actual observations by Austin over distances up to 1000 miles had led to an empirical formula differing only in that $\sqrt{\lambda}$ appears instead of $\sqrt[3]{\lambda}$.

The bulk of the evidence so far collected as to long distance transmission showed, however, that true diffraction of space waves or even the surface waves could not contribute more than a moderate fraction, perhaps not 20 per cent., to the total observed result. The chief part of the effect for distances of 3000 to 4000 miles must be contributed by space waves which had reached the receiving station indirectly, that is, after reflection or refraction at the surfaces of layers of high-altitude ionised atmospheric gases in the manner explained by Heaviside and by Eccles.

The great variations in signal strength taking place from day to day in long-distance wireless intercourse proved that this must be the case.

In conclusion, Dr. Fleming exhibited a chart showing the variation in the strength of the signals received at University College, London, from the Eiffel Tower station in Paris at 11 a.m. each day during last July, prior to the outbreak of war. The sudden falling off on certain days was remarkable. Dr. Fleming said that the further examination of the cause of these variations was one of the chief objects of the British Association Radio-telegraphic Committee which was appointed at Dundee in consequence of a suggestion made by him, and that as soon as the present calamitous world-war came to an end it was hoped these researches might be resumed.

THE CANADIAN ARCTIC EXPEDITION.

THE Scottish Oceanographical Laboratory, which had much to do with the oceanographical equipment of the *Karluk*, and especially the outfit of the Scottish contingent, consisting of Mr. James Murray, Dr. Alastair Forbes Mackay, and Mr. W. L. McKinlay, is in receipt of a considerable amount of official and private information concerning the Canadian Arctic Expedition. The expedition was hurried in its preparation and late in its departure, and the plans were "still pretty fluid" on July 21, 1913. On August 5 the *Karluk* was beset in 145° W., and drifted west to Colville River by September 7, and remained there until September 20, when she was blown adrift by a gale. Stefánsson and a party were ashore hunting on September 19, and were thus stranded. The *Karluk* drove north and west past Cape Barrow until she reached 73° N., 162° E.; then she drove southwest and west until, on January 10 last, she was crushed and sank in 38 fathoms sixty miles north by east of Herald Island. She drifted eight hundred miles at a rate of seven miles an hour. A perilous escape was made to Wrangell Island, at the heavy cost of eight lives, to which were afterwards added three more deaths on Wrangell Island, *i.e.* eleven in all.

This death-roll includes all the scientific staff except Mr. W. L. McKinlay, of Glasgow, a former assistant to Dr. W. S. Bruce. The other scientific workers missing or dead are Mr. James Murray, of Glasgow, late biologist of the Scottish Loch Survey, naturalist to the first Shackleton expedition, and worker upon the *Scotia* invertebrates; Dr. A. Forbes Mackay, of Edinburgh, who had had wide experience in many spheres of active life, including the Royal Navy, the South African War, and was member of the party that first ascended Mount Erebus, as well as that which reached the south magnetic pole under the leadership of Prof. David; Mr. Beauchat, anthropologist; Mr. Bjorn Mamen, topographer; and Mr. G. Malloch, geologist. Besides these, Mate Anderson, Second Mate Barker, and four seamen have also perished. Captain Bartlett, of North Pole fame, with an Eskimo, made an escape with difficulty from Wrangell Island to the mainland of Siberia, and there, with the help of the Russian Governor, Baron

Kleist, got Captain Petersen, of the whaler *Herman*, to take him to St. Michael. A gasoline schooner, *King and Wing*, of Seattle, relieved the Wrangell Island party, which was afterwards transhipped to the *Bear*. Stefánsson and two men started north from Martin Point on March 22, 1914, and on April 16 were to have returned after fifteen days. Stefánsson and his men have not been heard of since. He believed currents might drive them towards Banks Land, but on this coast, though searched, no trace of them has been found. The drift of the *Karluk* makes it unlikely that he has reached Banks Land.

BRITISH SUPPLY OF SYNTHETIC COLOURS.

THE Board of Trade has had under consideration the question of the supply of dye stuffs and colours, the shortage of which at the present time, owing to the cessation of imports from Germany, is causing apprehension in the textile trades and in other important British industries.

After consultation with the Committee on Chemical Manufactures, appointed in August last under the chairmanship of the Lord Chancellor, it appeared to the Board advisable to take such steps as were possible to develop the immediately available sources of supply, and also to encourage the permanent manufacture of dye stuffs and colours in the United Kingdom on a large scale, so as to guard against any recurrence of the present difficulty. As regards interim steps, arrangements have been made to encourage the immediate expansion of the various existing sources of supply.

As to the permanent supply, after preliminary consultations with representatives of some of the principal bodies of consumers, a meeting was held at the offices of the Board of Trade on November 10, and was attended by the representatives of twenty-two important associations and firms engaged in the colour-using industries. There was laid before the meeting a scheme for the formation of a limited company with a large capital, of which the bulk would be subscribed by the consumers of dyestuffs and colours and others interested, the Government indicating their willingness, conditionally on this being done, to subscribe a certain proportion of the share capital and to guarantee the interest on a large debenture issue for a term of years. Precautions would be taken to preserve the British control of the enterprise and to prevent undue encroachment on other branches of the chemical trades.

The meeting was informed that preliminary arrangements had been made enabling his Majesty's Government to acquire important dye-producing works in this country for the purposes of the new company if established, and that the Government would be prepared to take all necessary steps to secure the acquisition of any other concerns in the United Kingdom, the transfer of which to the new company might be desirable.

The meeting unanimously adopted a resolution approving in principle of a national effort being made by the trade to increase the British supply of synthetic colours and welcoming the assistance of his Majesty's Government for that purpose. A small committee representing the trades concerned was appointed to confer with the Board of Trade with a view to the elaboration of a scheme on the lines discussed at the meeting. The first meeting of this committee was held later in the afternoon. A further announcement as to the proposed company will be made at an early date.

METALLURGY AT THE ROYAL MINT.

ONE of the most interesting features of the forty-fourth annual report of the Deputy-Master and Comptroller of the Mint just received is the comparison of the melting costs according as coke or coal-gas is used as the fuel. The former was used up to the year 1909, but has since been replaced by the latter. Although the gross out-turn was 1197·7 tons in 1909, as against 1957·9 tons in 1913, the records are comparable, since the proportion of bronze and nickel-bronze—which require higher temperatures for melting than gold and silver—was nearly the same, viz., 56·3 per cent. in the earlier and 55 per cent. in the later year. The comparison is remarkably in favour of coal-gas firing, since there is a gross saving of 22·44 shillings per ton of bars, or 27·3 per cent. of the total charge in 1909. Moreover there is a saving under each item of expense, viz., fuel, crucibles, and wages. It is stated that "side by side with this economy there has been a marked increase in efficiency both in regard to the output per furnace and per man, as well as many minor economies, such as the disposal of ashes, handling of fuel, and a great reduction in the weight of sweep to be dealt with."

Sir Thomas Rose's experiments on the effect of impurities on the temperature at which gold is softened by annealing have been confirmed and extended by Mr. Phelps. The presence of two parts of hydrogen per 100,000 raises this temperature from 130° C. to at least 300° C. Silver has a similar, though less, effect. It has now been found that the relative purity of two samples of "proof" gold "can be more readily determined by heating hard-rolled test-pieces at 130–150° for half an hour than by ordinary methods of assay." The degree of softening is either measured in some form of hardness tester or is judged by the extent of recrystallisation of the metal. Sir Thomas Rose's experiments on the mode of recrystallisation of gold in various stages of annealing are of great importance, and bear directly on cases of failure of metal tubes and rods which are subjected to partial annealing conditions spread over lengthened periods of time.

The three countries—Austria, France, and Turkey—use pure nickel as a coinage metal. In the first-named this metal has been coined and issued regularly since 1892. In France it was adopted for 25 centimes only in 1903, but a new law passed on August 4, 1913, provides for the withdrawal of this issue and of the present bronze currency, and their gradual replacement by 25, 10, and 5 centime pieces, all of pure metal. The new issue will be spread over a period of ten years, and will amount to 780 million pieces. The French Government has signed a contract with a French nickel company for twenty years to purchase the requisite metal at 141*l.* a ton, the present price in the London market being about 171*l.* a ton.

Thirty-four countries use a 75 per cent. copper and 25 per cent. nickel coinage alloy, while Germany and Switzerland coin both pure nickel and the above-mentioned alloy.

H. C. H. C.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE physiological section of the British Association began its programme for the Australian meeting in Melbourne. Considerable alterations had to be made at the last moment owing to the unavoidable absence of members who were expected to contribute to a general discussion upon climate from a physiological point of view. This is a subject to which considerable attention has been paid in Australia, and very complete meteorological statistics from all parts of the country are available. Wet- and dry-bulb records of temperature, rainfall, and other particulars were furnished by the authorities, and the climatic conditions of Northern Australia in particular have already been analysed locally with a view to determine the possibility of the settling of these regions by a white population. Australians are determined to people their country with none but a white population, and one of the problems of the country is how to bring this about successfully under the diverse conditions which prevail in the large tropical areas of the north.

The time at the disposal of the section was reduced by alterations in the train arrangements between Melbourne and Sydney, and Sydney and Brisbane, and by the numerous interesting excursions and hospitalities so lavishly provided by the local committees. The conditions created by the war, too, naturally deprived the meetings of the interest which they would otherwise have occasioned. In spite of this the meetings were very successful, especially in Melbourne, and it was only towards the close in Sydney that interest in the business of the section slackened.

A very full programme was presented and carried out in Melbourne. Prof. B. Moore opened the proceedings of the section by an address upon the value of research in the development of national health, and put in a strong plea for the wider application of modern scientific discoveries to the promotion of the health of the race. Sir Edward Schäfer exhibited a number of lantern slides of sections of the mammary gland, and pointed out the presence around the alveoli of non-striped muscle fibres. It is to the contraction of these fibres that he ascribes the lactagogue effect of injections of pituitrin. Prof. Halliburton, in collaboration with Dr. W. E. Dixon, gave an account of their recent investigations into the physiology of the cerebro-spinal fluid. Numerous lantern slides were shown illustrative of the response to intravenous injections of various extracts by the production and pressure of the cerebro-spinal fluid. They find extracts of dried choroid plexus to be especially active in increasing its production. Certain anæsthetics, and excess of CO_2 in the blood particularly, are also powerful stimulating agents. Evidence was adduced to prove that cerebro-spinal fluid is a true secretion, and that it is largely formed by the cells of the choroid plexus. The hormone may be a product of nervous metabolism, and the cerebro-spinal fluid may be an important agent in the rapid elimination of CO_2. A number of interesting observations upon the changes of cerebro-spinal pressure relative to the arterial and venous pressures were illustrated, a full account of which is given by the authors in recent numbers of the *Journal of Physiology*.

Prof. W. A. Osborne described experiments performed by himself, and in conjunction with Mr. Basil Kilvington, in Melbourne, upon pseudo-motor action, recurrent sensibility, and central neural response. Mr. Basil Kilvington also reported an experimental method of bringing about a successful collateralisation after occlusion of the abdominal aorta, a procedure which might be useful in surgery. Dr. E. H. Embley contributed a paper upon evidence of co-ordinate action in the circulatory system.

The second day's meeting in Melbourne was begun by a general discussion upon anæsthetics. Prof. A. D. Waller demonstrated a portable apparatus for the administration of chloroform, and dwelt upon the chief dangers to be feared in anæsthesia, and upon the question as to what are the real causes of danger. Dr. E. H. Embley, whose work in Melbourne upon anæsthetics is so well known, discussed the causes and treatment of syncope, excessive intoxication, shock, and various accidental conditions. Prevention of syncope and shock he believes to be best attained by the pre-anæsthetic injection of morphine and atropine, and by the use of ether, or ether and oxygen, instead of chloroform. Dread of operation by the patient is also largely mitigated by the preliminary use of morphine. Prof. Osborne and Prof. Milroy continued the discussion, the latter describing the effect of anæsthetics upon the electro-cardiogram. Prof. R. F. C. Leith showed lantern slides of the pathological changes in a case of delayed chloroform poisoning, and Prof. Waller summed up the discussion.

Dr. J. W. Barrett then contributed an important paper upon the vision of persons engaged in navigation and railway services. He strongly advocated the thorough testing at the earliest possible time of the eyesight of all who contemplate entering either service, so that if the candidates are unsuitable rejection will take place before they have spent time and money in their training. Legislation is required for the purpose. Dr. Barrett instanced a series of accidents which were clearly due to defective vision, and which would have been avoided if a thorough examination of the sight of the men in charge had been carried out. The committee of the section passed a resolution recommending the Council of the Association to print Dr. Barrett's paper *in extenso*.

Miss Kincaid read a paper upon the biochemical significance of phosphorus, and claimed to have shown by analysis that there is a general deficiency of phosphorus in the soil and flora of Australia. Further work upon this question is to be done and reported to the Association.

Dr. S. Sewell contributed a paper upon the mechanism of micturition control in human beings.

The reports of several research committees were presented. Very little discussion of the individual contributions was possible owing to the shortness of time at disposal.

The work of the section was continued at Sydney. Sir Thomas Anderson Stewart demonstrated a number of interesting models illustrating physiological processes, *e.g.*, the functions of the corpora Arantii, the nature of sound waves in air, the action of the stapedius muscle, and the effect of simultaneous contraction of the intercostal muscles. A cyclograph, or apparatus for quickly marking microscopical slides for the identification of any part under the microscope, was also shown.

Prof. W. A. Osborne was to have opened a discussion upon climate, but as there were no other speakers on the subject he confined his observations to a consideration of the methods of taking temperature by wet-bulb thermometers. The ordinary wet-bulb thermometer is not so sensitive to changes in wind velocity as the human body, and Prof. Osborne described a method of jacketing wet-bulb thermometers so as to render them much more sensitive to changes in air currents. He also emphasised the importance of wet-bulb temperature records from a physiological point of view.

Prof. B. Moore gave the section the results of his repetition of some of the experiments of Dr. Bastian on inorganic colloids. He showed numerous slides illustrating the appearance of branching networks and hyphæ. There were no micrococci or other signs of life. Prof. Moore believes that the appearances are merely precipitation forms, the solutions are isoelectric, and give no signs of life. Considerable discussion followed, especially upon the question of infection of the solutions, and upon the methods of determining the presence of any vital activity in them. Other communications by Prof. Moore dealt with the action of ultra-violet light upon solutions of organic substances, and with the presence of iron salts in the colourless portion of the chloroplast, and the mechanism of photo-synthesis by iron salts. Mr. Halcro Wardlaw, a science research scholar of Sydney University, described the results of a series of analyses of the deposit obtained from milk by spinning it in a centrifuge, and Dr. Burton Bradley contributed some notes on the symbiotic activities of coliform and other organisms on media containing carbohydrates.

The last day's proceedings of the section in Sydney embraced a lengthy programme, but most of the papers were taken as read, and the section thereafter joined those of chemistry and agriculture in a discussion upon metabolism. Among the subjects brought before the section, and of which abstracts were printed, were papers by Prof. T. H. Milroy on changes in the reaction of milk under different conditions as determined by the estimation of hydrogen-ion concentration by the electrometric method, and measurements of the variations of the hydrogen-ion concentration of the blood. Prof. P. T. Herring contributed papers upon the relative activity of the pars intermedia and pars nervosa of the ox pituitary, and upon the influence of the thyroid upon the activity of the suprarenals and pituitary body. In the latter communication the chief point of interest was the loss of chromaffine-substance, and corresponding diminution of activity, of the medulla of the suprarenals which rapidly follow thyroidectomy; thyroid-feeding, on the other hand, though pushed to an extreme, has no such effect. Dr. H. G. Chapman presented a paper on the freezing point of the laked red blood corpuscles of man and some domesticated animals, and Dr. C. Shellshear a paper on precipitin reactions in pathological human urines.

Several papers on psychological subjects appeared on the programme, but it was found impossible to take them. A feature of the sectional business in both Melbourne and Sydney was the large and varied contributions by local members, evincing evidence of the activity of the physiological departments in these universities.

AGRICULTURE AT THE BRITISH ASSOCIATION.

THE paramount importance of agriculture in Australia rendered the proceedings of Section M of special local interest, and the addresses and papers were arranged to deal with subjects of real significance in that country. The two addresses delivered by the president, Mr. A. D. Hall, attracted large audiences both at Adelaide and Brisbane. They were read at sessions of the whole association, and formed as valuable a contribution to Australia's needs as agricultural science and research could well have provided.

The meetings of the section at Melbourne were devoted to the subjects of irrigation, dry farming, animal breeding, and milk supply, all of which were selected in view of their importance to the Australian agriculturist. The papers on irrigation were read at a joint meeting with Section G (Engineering), and an account of the discussion has been given in the report of the proceedings of that section (November 5, p. 266).

An excellent paper by Dr. Lyman J. Briggs on dry farming investigations in the United States gave a *résumé* of the systematic work which has been carried on for many years in America on this subject. Dr. Briggs illustrated his paper with maps and diagrams, and pointed out the differences which exist between the problems in America and those in Australia. Differences in the distribution and amount of the rainfall and in the nature of the soil indicate the necessity for much investigation into the special problems of each district. A more restricted problem of special Australian interest, "The Ten-inch Line of Rainfall," was discussed by Dr. T. Cherry, who pointed out that the rainfall throughout the southern third of the continent is almost exclusively of the winter type, and that the winter temperatures are high enough to keep the ordinary cereals growing during these months. The chief problem which in this instance has now to be solved is to devise methods by which sheep and cattle can also be profitably kept on the wheat farms in the 10-in. line of rainfall, the area already having been proved very suitable for wheat.

The very high evaporation factor, which in Western Australia is four to six times greater than the rainfall, adds to the difficulty of maintaining the soil moisture. Prof. J. W. Paterson contrasted this evaporation with that in England, which is only about one-half of the annual rainfall. He also stated that the sandy soils in these dry districts are an advantage, as they are able to absorb all the rain which falls and can yield up the retained moisture more completely to the plant than more absorbent clay soils. The movement of air and water within the soil is dependent on the sizes and distribution of the free spaces between the particles, a subject dealt with by Dr. Heber Green, who spoke of the capillary power of soils and of the experiments and calculations which he had made on this subject.

Perhaps no branch of scientific research is likely to be of more direct practical value than the investigations into the laws of inheritance. In the field of animal breeding Mr. P. G. Bailey represented the Cambridge school, and reported the progress of experiments conducted on the inheritance of wool characters in a cross made between two Merino rams from Western Australia and twenty Shropshire ewes at Cambridge. He also contributed a paper on size inheritance in poultry, a subject which bids fair to yield results of practical importance to an industry which is assuming large proportions in Australia.

The improvement of the quantity and quality of milk yield has received a great impetus in late years by the keeping of milk records and the gradual elimination of the less productive cows from herds. The development of this work in England, Scotland, and Ireland was reviewed by Dr. A. Lauder. Dr. S. S. Cameron and Mr. O'Callaghan spoke of developments in this direction in Australia.

The high cost and scarcity of labour in Australia has forced the development of milking machines. Mr. Archer estimated that in Victoria alone 2000 farmers had been supplied with milking machines, and that about fourteen different makes were in use. The principal local feature is the conduit system, in which the milk is conveyed through metal pipes to a tank in the dairy, thus saving the labour of carrying the milk.

The scientific comparison of the bacteriological purity and keeping qualities of milk obtained from eleven different types of machine at trials arranged by the Royal Agricultural Society of England formed the subject of a paper by Dr. R. Stenhouse Williams, Mr. J. Golding, and Mr. J. Mackintosh. The difficulties in cleaning many of the machines, especially those fitted with long rubber tubes, is one of the chief drawbacks to their employment under existing conditions on many farms.

A visit to the State experimental farms in Australia is sufficient to show the very great importance attached to the subject of cereal breeding. Not only is a large area of these many farms devoted to experiments on this subject; but the keen interest taken by the staffs in scientific investigation in other parts of the world and the enthusiasm in the work of William Farrer and other Australian investigators cannot fail to impress the visitor. A whole meeting at Sydney was not sufficient to exhaust the papers and discussion on cereal breeding. The papers read were as follows:—"The Migration of Reserve Material to the Seeds in Barley, considered as a Factor in Production," by Mr. E. S. Beaven; "Wheat Improvement in Australia," by Mr. F. B. Guthrie; "William Farrer's Work, Methods, and Success: a Short Sketch," by Mr. J. T. Pridham; "Wheat Breeding in Australia," by Mr. A. E. V. Richardson. Prof. Bateson, Mr. A. D. Hall, Prof. T. B. Wood and others took part in the discussion. The value of the Mendelian theory in providing a speedy and certain method for the practical man, and in directing his problems on scientific lines was illustrated by Mr. Beaven's work on barley. He showed that the ratio of the dry matter accumulated in the seed, to the total dry matter of the plant when fully ripe, frequently influences the produce of grain to a greater extent than any other factor. This "coefficient of migration" differs with different races of barley within the gross productive power which is a product of the environment.

A joint discussion with Section B (Chemistry) on metabolism, which took place at Sydney, will be reported in an article on the work of that section. Other papers contributed included "Flax as Paying Crop," by Mr. C. P. Ogilvie; "Bacterial Toxins in Soil," by Dr. Greig Smith; "The Estimation of Condition in Cattle," by Mr. J. A. Murray; "A Review of Work on Soil Inoculation," by Dr. H. B. Hutchinson, and Mr. J. Golding; and "The Effects of Caustic Lime and Chalk on Soil Fertility," by Dr. H. B. Hutchinson and Mr. K. MacLennan.

Highly satisfactory as they were, the proceedings of the section in session cannot be taken as a measure of the work achieved in 1914, for the unique advantages which members of the section gained by a visit to so rich and varied a field of agricultural endeavour cannot fail to bear fruit rich in its benefit to the science of agriculture.

It is only possible briefly to refer to the numerous and valuable agricultural excursions which were specially arranged, not only to meet the wishes of the whole section, but also to enable individual members to make independent visits to farms and districts where the branches of agriculture in which they had specialised were seen to the best advantage.

In Western Australia the latter type of excursion prevailed, and, under the personal guidance of Mr. W. Catton Grasby, Mr. J. L. Sutton, Prof. Paterson, Dr. Stoward, and Mr. A. E. Weston, visits were made to see the great developments which have recently taken place in corn growing, fruit growing, and other departments of agriculture in the great south-west area of this promising State.

From Adelaide excursions were made to Angaston, Seppeltsfield, and Tanunda. Mr. Charles Angas entertained a large party to lunch at Angaston. Vineyards and the agricultural land in the neighbourhood were afterwards visited. Roseworthy Agricultural College was the objective of a most interesting excursion from Adelaide. The instruction given to students is of a very practical nature, the buildings and laboratories are good, and the farm very well laid out in experiments on crops and stock. The introduction of Berseem (*Trifolium alexandrium*) on an irrigated plot of four acres had proved very successful, twenty-five cows having been kept on the produce of the plot for five months during the winter, the yield of green food being 36 tons per acre.

In Victoria the principal agricultural excursion was to the Central Research Farm at Werribee. Although only started in 1912, this farm of more than 1000 acres is admirably laid out in experiments on dry farming, irrigation, and live stock. The organisation was quite a model for similar institutions; a large party was conducted over it in a most thorough manner, all the experiments being ably explained by the staff and authorities from Melbourne.

From Sydney a three days' excursion was arranged which included visits to the Wagga Experiment Farm, Mr. Anthony Brunskill's 12,000 acre farm, and two days in the interesting Murrumbidgee irrigation area, including the Yanco Government Irrigation Farm and Works. Motor-cars were provided, and nights were spent in a special sleeping car.

Mr. Wade, who himself conducted the party over the irrigation area, gave a lecture and showed lantern slides and plans of this great scheme, which will provide nearly 7000 farms and support a population of 100,000 people on land which until the scheme was taken up by the Government was used as sheep runs. The famous Hawkesbury Agricultural College was also visited from Sydney, where accommodation for 200 resident students is provided; the farm comprises some 3440 acres of land. All branches of farming, especially the orchard, dairy, piggery, and poultry farm, were well worth a visit.

The cultivation of sugar cane and a sugar mill in full work was inspected at Nambour, Queensland, by a large party, and opportunities were afforded for smaller parties to see the work on the eradication of the prickly-pear, and to visit large sheep farms, etc.

The most striking feature in the visits to experimental farms in most parts of Australia was the response shown by the crops to phosphatic manures, even when, as is the practice, very small dressings were applied with the combined manure and seed drill. In one case in Western Australia 30 lb. of superphosphate added per acre had doubled the yield of wheat (9 bushels raised to 18). Sixty to 80 lb. of superphosphate per acre were commonly used in this excellent drill.

The section met with the greatest kindness and hospitality on all sides, and it is invidious to particularise amongst such a number of generous and indefatigable hosts, but special thanks are due to Mr. W. Hutchinson, Minister of Agriculture for Victoria, Dr. Cameron, Dr. Cherry, and Mr. Richardson, of Melbourne, and to Prof. R. D. Watt, of Sydney, for the part they took in carrying out the many and valuable excursions

BUDGETS AND STUDENTS OF UNIVERSITIES AND UNIVERSITY COLLEGES IN RECEIPT OF STATE GRANTS.

THE reports for the year 1912–13 from those universities and university colleges in Great Britain which are in receipt of grant from the Board of Education have been published in two Blue-books (Cd. 7614 and Cd. 7615). The tabular matter, which precedes the separate reports from the places of higher education dealt with, contains detailed information as to the income and expenditure of the various institutions concerned. The following summaries have been compiled from the tables, and make clear the amount available for higher education and research in the universities and university colleges receiving Treasury grants, and how the income is expended.

UNIVERSITIES AND UNIVERSITY COLLEGES.

(1) ENGLAND.

(a) Income.

	Amount £	Percentage of total
Fees	183,880	27·8
Endowments	95,045	14·4
Donations and subscriptions	22,381	3·4
Annual grants from local authorities	103,650	15·7
Parliamentary grants ...	232,821	35·2
Contributions from hospitals, etc., for services rendered	2,338	0·4
Other income	20,486	3·1
	660,601	

(b) Expenditure.

Administration	68,329	10·3
Maintenance of premises	68,670	10·4
Educational expenses ...	425,515	64·3
Superannuation	22,840	3·4
Other expenditure in respect of maintenance ...	30,219	4·6
Expenditure not in respect of maintenance ...	46,288	7·0
	661,861	

(2) WALES.

(a) Income.

	Amount £	Percentage of total
Fees	17,456	27·7
Endowments	4,448	7·1
Donations and subscriptions	2,330	3·7
Annual grants from local authorities	3,441	5·5
Parliamentary grants ...	34,217	54·3
Other income	1,132	1·7
	63,024	

(b) Expenditure.

Administration	8,020	11·8
Maintenance of premises	4,597	6·8
Educational expenses ...	48,232	71·0
Superannuation	1,733	2·5
Other expenditure in respect of maintenance ...	497	0·7
Expenditure not in respect of maintenance ...	4,891	7·2
Total	£67,970	

On comparing the statistics with those of the previous year, it is noticed that in England the total income of the institutions has risen by 38,000*l*., which is made up as follows: the fee income has risen by 3000*l*., the income from endowment by more than 9000*l*., that from local authority grants by nearly 8000*l*., while Parliamentary grants supplied nearly 18,000*l*. additional assistance, though part of the income from this last-mentioned source, is derived from grants which are referable to previous years.

Certain individual figures are interesting. Manchester University has an income from endowment of rather more than 22,500*l*., and Liverpool University one of nearly 15,000*l*. Reading University College has an endowment income of practically 9000*l*., which represents more than 31 per cent. of its total revenue. The largest proportions of income derived from grants from local authorities are found at the University Colleges of Southampton and Nottingham, in both of which cases nearly 40 per cent. of the income is provided from this source. Similarly, 29 per cent. of the income of Sheffield University is obtained from grants from local authorities.

The total expenditure in England has risen by nearly 60,000*l*. Nearly 4000*l*. of this increase is accounted for by administration, nearly 5000*l*. by cost of maintenance of premises, rates, etc., and more than 30,000*l*. by expenditure on teaching salaries and equipment. More than 9000*l*. additional expenditure was incurred on superannuation provision, for which increased grants have recently been made. Seven per cent. of the total expenditure at all institutions was made in respect of charges of a non-maintenance character. The highest percentages for these charges are at Sheffield, 18·5 per cent.; Birmingham, 14 per cent.; King's College for Women, 12·3 per cent.; and Bedford College, 10·2 per cent.

A new table indicates the amount of grant aid given to university institutions under the provisions of the "Statements of grants available from the Board of Education in aid of technological and professional work in universities in England and Wales" in the financial years 1912–13 and 1913–14. The total amount of grant aid under these provisions rose from 41,647*l*. in the financial year 1912–13 to 44,623*l*. in 1913–14. The total amount of Exchequer grants in England in aid for universities and university colleges in the year 1912–13 was 170,000*l*., and, in addition, 31,000*l*. was paid to university colleges in Wales.

In addition to the financial statistics, the reports contain much useful information concerning the number of students in the various colleges, their ages, the subjects they are studying, and so on; and the following tabular statements will serve to summarise them. It is necessary to point out that the numbers concern only the following institutions:—The Universities of Birmingham, Bristol, Durham (Armstrong College), Leeds, Liverpool, Manchester, Sheffield, London (including University College, King's College, Bedford College, School of Economics, and East London College), and also the University Colleges of Nottingham, Reading, and Southampton. The University of Wales includes the University Colleges of Aberystwyth, Bangor, and Cardiff.

NUMBER OF FULL-TIME STUDENTS.

	England	Wales
Degree Students:—		
Training college	1397	420
Others	3402	648
Total	4799	1068
Non-graduate (diploma) students:—		
Training college	644	8
Others	1113	98
Total	1757	106
Post-graduate students:—		
Training college	29	—
Others	479	76
Total	508	76
Other courses	602	39
Total	7666	1289

NUMBER OF PART-TIME STUDENTS.

Day.

	England	Wales
Degree	229	4
Non-graduate (diploma) ...	182	29
Other courses	3406	297
Post-graduate	1023	19
Carried forward ...	4840	349

Brought forward (*Day*)	4840	349
Evening.		
Degree	363	—
Non-graduate	764	—
Other courses	7576	—
Post-graduate	255	—
Total	13,798	349

In England the total number of full-time students at these institutions of higher education in 1912–13 was 7666, as compared with 7827, in the previous year. The total number of part-time students has, on the other hand, increased from 13,348 to 13,798. The fall in the total number of full-time students is due to a decrease of fifty-six in the number of training college students and of 105 other students, making 161 in all. The number of full-time post-graduate students has risen by fifty-four, and the number of full-time diploma students by 103. On the other hand, there has been a fall of 159 in the number of students reading for degrees, and another of 159 in the number of students of undergraduate standing who were not reading for a degree.

It would appear, the report points out, that the rate of increase in the number of full-time students has been diminishing for some years past. The position is not satisfactory from the wider national point of view. There is little doubt that the commercial prosperity of the country during recent years has had a good deal to do with this diminution in the number of students who are seeking a university education. Furthermore, the bulk of the parents of the boys and girls in the State-aided secondary schools of the country have little sense of the value of a university education. Only a minority of these schools send students to the universities unless they happen to be placed in or very near to the university towns. It is not suggested that it would benefit all boys to go to a university without regard to their means or their ability and without a careful selection of their course of study, but there are grounds for thinking that the demand for healthy and able young men with a university training is beginning to outrun the supply. The openings for administrators of various kinds and for teachers in the Indian Empire and in the Crown Colonies are increasing in number, while suitable candidates are not. Nor is the demand confined to service abroad.

The Royal Commissioners on the Civil Service are evidently of opinion that the newer universities are not contributing a due proportion of candidates for the Home Services. "We should be glad," they say, "to see the Scottish, the Irish, and the young English and Welsh universities assert more vigorously their claim to share in Civil Service appointments." That they have not done so in the past is in part due, no doubt, to the character of the examination, but it is largely explained by the younger age at which their students graduate—in itself evidence of a hurried education—and partly by the diversion of some of the brightest minds in the schools to the practical world of business before the secondary stage of their education is complete. It is doubtful whether even the commerce of the country will benefit in the long run by this impatience; it is certain that the national and Imperial Services lose the variety of training and upbringing which is to be desired in their recruits.

By comparing the figures in England for 1911–12 with those for 1912–13 the following statistics are obtained:—

STUDENTS IN VARIOUS FACULTIES.

	1911–12	1912–13
Arts	3529	3405
Science ...	1726	1704
Medicine ...	2597	2697
Engineering ...	1105	1059
Technology ...	347	361
Agriculture ...	186	206

This table shows the number of full-time students in all institutions coming within the scope of the report, arranged according to the faculties in which they are studying.

It will be noticed that the fall in students which has been previously mentioned is confined to the faculties of arts, science, and engineering. The greatest actual fall is in the arts faculty, but the relative fall is equally great in the faculty of engineering. In the faculties of medicine, agriculture, and technology there has been an increase.

AGE OF ADMISSION OF FULL-TIME STUDENTS.
(1912–13.)

	England	Wales
Number admitted	3241	371
Percentage under 17	4·9	1·6
Percentage 17–18	12·7	8·9
Percentage 18–19	24·5	32·3
Percentage above 19	57·9	57·2

It should be pointed out that the number of students under England in this table includes 257 students at the nine medical schools of the University of London, and forty-two students at the College of Medicine, which is a constituent college of the University of Durham.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—The University has offered academic hospitality to accredited teachers and students of Belgian universities who have taken refuge in Glasgow. The heads of the several departments will afford them such facilities for study and research as it may be found practicable to provide.

The bequest of some 12,000*l*., left for the department of naval architecture under the will of the late Dr. Francis Elgar, has now accrued to the University. An equal amount is bequeathed to the Institution of Naval Architects.

Mr. S. Mavor, of Glasgow, has presented to the geological department a collection of more than 500 specimens, illustrative of the coal-beds of Great Britain and the continent of Europe.

Mr. A. Fleck, formerly demonstrator to Prof. Soddy, has been appointed physical chemist to the Glasgow Radium Committee, established to administer a large fund collected in the city for the purpose of acquiring and distributing radium for therapeutic purposes. A radiometric laboratory, under the auspices of the committee, has been fitted up at the University.

IT is known that there are many Belgian medical graduates refugees in this country who may find it difficult to obtain suitable accommodation. To meet this need the committee of the London School of Tropical Medicine will be pleased to hear from Belgian medical men who may desire to avail themselves of the hospitality of the school to the extent of board and residence in the hostel attached thereto. The Committee also invites any graduate so resident to attend the various classes while the school is in session.

THE first meeting of the re-constituted Agricultural (previously Rural) Education Conference was held on Tuesday, November 10, Lord Barnard being in the chair. The conference appointed a committee, composed partly of its own members and partly of women co-opted for the special purpose, to consider the following reference received from the Board of Agriculture and Fisheries: "To consider the provision made in England and Wales for the agricultural education of female students of sixteen years of age and upwards, and to report whether the existing facilities are sufficient, and if not, to what extent and in what direction these should be developed and improved."

TEACHERS of domestic subjects in schools and colleges who desire to give their instruction a scientific character continually find that some of the commonest observations and methods of domestic work are very difficult to explain. To assist such teachers to arrive at satisfactory explanations of the various steps in common domestic practice, the Association of Teachers of Domestic Subjects has appointed a science committee to which problems that arise may be referred for elucidation or investigation. Prof. Smithells is chairman of the committee, which includes several well-known chemists as well as practical teachers of domestic subjects. The report of this committee for 1914, which has been received, contains abundant evidence of the utility of the work of the committee, and every teacher of domestic subjects should study the answers to the questions discussed in it.

THOUGH the University of Bristol is one of the youngest of English universities its calendar for 1914–15, a copy of which has been received, shows that it is making rapid strides in the direction of providing a very complete system of higher education for the western counties of England. There are in the University faculties of arts, science, medicine, and engineering. We observe, among other interesting arrangements, that an alternative curriculum is provided so that undergraduates pursuing the study of agriculture and forestry may take an ordinary bachelor of science degree. Regulations are included by which students may secure the degree of bachelor of science in engineering by research. Those students who are not qualified by matriculation to proceed to a degree, may in certain circumstances procure a certificate in engineering. The University also, we notice, confers testamurs in social science and journalism. Among institutions associated with the University may be mentioned the Royal Agricultural College at Cirencester, the National Fruit and Cider Institute at Long Ashton, and the Agricultural and Horticultural Station at Long Ashton.

THERE is a tendency among popular philosophers and supernaturalists just now to suggest that modern science is crude materialism against which a spiritual reaction is to be encouraged. Some justification might have been found for such a view a generation or two ago, but the dogmatism of those days, both of men of science and theologians, has given way to a more liberal spirit, and all who are seeking earnestly for truth are considered to be worshippers at the same shrine. We are glad, therefore, to direct attention to a series of addresses upon the mutual relations between science and religion to be delivered by scientific men of distinction at Browning Hall, Walworth Road, S.E., during the week bebeginning on Sunday next, November 22. The addresses are intended for working men and women, students and teachers, and they will be delivered by Sir Oliver Lodge, Prof. J. A. Fleming, Prof. W. B. Bottomley, Prof. E. Hull, Dr. J. A. Harker, Prof. Sims Woodhead, and Prof. Silvanus Thompson; all seats will be free. There is, of course, no conflict between religion and science; one is the expression of an instinct, the other is a spirit of inquiry into the character and meaning of all things, visible and invisible, in the universe. It is particularly important at the present time to show that science is an uplifting study, and not merely the handmaid of material advance. Ruskin described the difference between science and invention long ago, but it is forgotten by most writers, and we trust that the addresses to be given at Browning Hall will do something to remove mistaken popular impressions as to the aim and meaning of scientific work.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, November 4.—Dr. A. Smith Woodward, president, in the chair.—L. **Richardson**: The inferior oolite and contiguous deposits of the Doulting-Milborne-Port District (Somerset). This paper embraces the country around Bruton, Castle Cary, and Blackford. In the northern half of the Doulting-Milborne-Port district the bulk of the yellow Upper-Lias Sands is of *dispansi* hemera; but in the neighbourhood of Cole and Castle Cary the topmost portion is of *dumortieriae* hemera. In the south-eastern portion, under Stowell, while the main mass is probably of *moorei-dumortieriae* hemeræ, the upper 50 ft. is of *aalensis-moorei* date. Rock of *garantianae* hemera spreads over the whole district. From Doulting to Bruton the Garantiana beds rest directly on the Sands. In the neighbourhood of Cole there is a synclinal area, and beds of *blagdeni, sauzei, witchelliae, shirbuirniae, discitae,* and *murchisonae* hemeræ are seen between the Garantiana beds and the Sands. At Corton Downs are rocks of *sauzei, witchelliae, shirbuirniae, discitae, bradfordensis,* and *murchisonae* hemeræ. In this southern portion of the district it is difficult to determine the upper and lower limits of the deposits of *discitae, shirbuirniae,* and *witchelliae* hemeræ. The rock of *garantianae* hemera varies much from place to place in thickness and lithic structure. Above the Garantiana beds come the Douling Stone, Anabacia Limestones, and Rubbly beds. The Anabacia Limestones soon lose their lithic characters; but the Doulting Stone spreads over the Oolitic tract, and is exposed in numerous quarries. In the southern portion of the district, the lower portion of the equivalent of the Hadspen Stone passes into the Sherborne Building-Stone, and the top portion, *plus* higher beds, into the Rubbly Limestone beds, such as those displayed in quarries in the eastern portion of the Sherborne district.—E. T. **Paris** and L. **Richardson**: Some Inferior-Oolite pectens. Descriptions and illustrations are given of one new species of Camptonectes, of two new varieties of *Chlamys articulata* (auctt.), and of two new species of Velopecten.

Linnean Society, November 5.—Prof. E. B. Poulton, president, in the chair.—A. D. **Cotton**: The algæ, lichens, and fungi of the West Falkland Islands, from Mrs. Rupert Vallentin's collections. A large collection was made by Mrs. Vallentin from 1909 to 1911, and was presented by her to the Royal Botanic Gardens, Kew; the present paper dealt with those Cryptogams mentioned in the title, the Mosses and Hepaticæ being reserved for later work. These collections are valuable and have yielded interesting results, including several novelties, and many additions to the flora, and by means of ample, well-dried material, enabled previous descriptions to be enlarged and revised. The author gave an historical account of the cellular Cryptogams from the earliest record (1771) to the present time, and included in his list all previous records, revised so far as practicable.

Mathematical Society, November 12.—Annual general meeting.—Prof. A. E. H. Love (retiring president) and afterwards Sir Joseph Larmor (newly-elected president) in the chair.—Prof. **Love**: Presidential address, "Mathematical Research." Prof. G. A. **Miller**: Note on an extension of Sylow's theorem.—J. **Hodgkinson**: The conformal representation of the various triangles bounded by the arcs of three intersecting circles.—G. R. **Goldsbrough**: The dynamical theory of the tides in a zonal basin.—G. H. **Hardy**: The modulus of an analytic function.—Prof. W. **Burnside**: (i) The modification of a train of waves as it advances into shallow water. (ii) A configuration of 21 points and 21 lines which arises from the complete quadrilateral and determines the group of 168 plane collineations.—Prof. Tadahiko **Kubota**: Convex closed surfaces.—Prof. W. H. **Young**: Integrals and derivates with regard to a function.

Mineralogical Society, November 10.—Anniversary meeting.—Dr. A. E. H. Tutton, president, in the chair.—Prof. W. J. **Lewis**: Albite; its crystal elements, etc. New values of the elements were obtained based upon measurements made on well-developed twinned crystals from Alp Rischuna. Chemical analysis showed them to be very pure albite.—H. **Collingridge**: The determination of the maximum extinction angle, optic axial angle, and birefringence of monoclinic pyroxenes in thin sections. The method depends on the presence of well-defined twins about 100, and the visibility of an optic axis through one individual. From observations in this individual of the positions of the trace of the optic axial plane and the twin plane, the extinction angle, and the position of the visible optic axis, and in the other the extinction angle and the birefringence, and, if possible, the positions of an optic axis and the trace of the optic axial plane, the requisite determinations may be made.—Prof. H. L. **Bowman**: Note on calcite from the Chalk at Corfe Castle, Dorset. Good crystals, which occur in veins in the Upper Chalk, are of the pointed habit, the forms being f (11$\bar{1}$) and x (21$\bar{2}$). Interpenetrant rhombohedra twinned about the c axis, as in cinnabar, are not uncommon.—A. **Scott**: Barkevikite from Lugar, Ayrshire, and litharge from Persia. The former occurs in lugarite in prismatic crystals up to 75 mm. in length, with mean refractivity 1·690, and very intense pleochromism, c very dark brown, b reddish-brown, a light yellow; in chemical composition it is fairly close to the type mineral from Barkevik. The latter was found at Larshuran, Persia, as a red mica-like crystalline mass; it is biaxial with mean refractivity 1·735, the double refraction being very weak, and contains more than 97 per cent. of lead oxide, the remainder being copper oxide with a little antimony oxide.—Dr. G. T. **Prior**: The meteorites of Uwet, Kota Kota, and Angela; the identity of Angela and La Primitiva. The meteoric iron of Uwet, Southern Nigeria, said by natives to have fallen about ninety years ago, is a hexahedrite of the Braunau type, containing about 6 per cent. of nickel. The meteoric stone of Kota Kota, Marimba district, British Central Africa, said by natives to have been seen to fall some years ago, is a chondrite, probably belonging to the crystalline spherulitic group. The meteoritic iron of Angela, near Iquique, Chili, was found in the nitrate beds. It is an ataxite, containing about 4·5 per cent. of nickel, and enclosing large nodules of schreibersite, and is probably identical with La Primitiva.

EDINBURGH.

Royal Society, November 2.—Prof. James Geikie, president, in the chair.—Sir William **Turner**: The Baleen whales of the South Atlantic. The paper was essentially a comparison of certain anatomical characteristics of specimens of whales recently found in the South Atlantic with those of the better known whales of the North Atlantic. The conclusion was that of the Balænopteridæ, five species were common to the north and south Atlantic oceans, namely, *Megaptera boops* (*longimana*), and the four species of *Balaenoptera*, *sibbaldi*, *borealis*, *rostrata*, *musculus*. Similarly the smaller right whale, *Balaena australis*, which frequents the temperate waters of the South Atlantic, is obviously the same species as the *Balaena biscayensis* of the North Atlantic. On the other hand, *Balaena mysticetus* of the Arctic Ocean appears to have no representative in the Antarctic.—Dr. J. E. **Mackenzie** and S. **Ghosh**: The optical rotation and cryoscopic behaviour of sugars dissolved in (1) formamide, (2) water. The mutarotation of the sugars, *β-l*-arabinose, *l*-xylose, *a-d*-glucose, *a-d*-galactose, *d*-mannose, *d*-fructose, *a*- and *β*-lactose, dissolved in the solvents named, was measured and found to be of the same character. The molecular weights of the same sugars dissolved in these solvents were also determined, and each sugar was found to be in the monomolecular state. The results of the optical rotation measurements in formamide, like those obtained in pyridine solution by Grossmann and Bloch, appear to show that the presence of water is not essential to explain the phenomenon of mutarotation of sugars.

PARIS.

Academy of Sciences, November 3.—M.P. Appell in the chair.—A. **Lacroix**: The products of alteration of aluminium silicate rocks, and, in particular, the laterites of Madagascar.—G. **Lippmann**: The Hughes electromagnetic balance and its application to medical surgery (see p. 319).—D. **Eginitis**: Observation of the solar eclipse of August 21, 1914, made at the Athens Observatory with the Doridis equatorial (Gautier, 40 cm.). Particulars are given of actinometric observations, and of measurements of air temperatures, relative humidity, barometric pressure, and wind velocity.—M. **Guéritot**: An experimental method of determining the metacentric curves of an aeroplane. Details of experiments made on a model fixed to a float in water.—J. **Bougault**: The dioxytriazines. The reaction between the semicarbazides of *a*-ketonic acids and aqueous soda solution takes place in the cold. The yield is better than when the experiment is carried out at the boiling point, but the reaction velocity is very slow. The dioxytriazines react with sodium hypobromite, giving substituted amides of the type $R.CBr_2.CO.NH_2$.—G. A. **Le Roy**: The waterproofing of military clothes. The whole garment is impregnated with lanoline, by immersion in a solution in a volatile solvent containing from 5 per cent. to 10 per cent. of the wool fat. The cloth remains permeable to air, but is impermeable to water.—Marcel **Baudouin**: The ossification of the metacarpal and metatarsal bones in men of the polished Stone age.

BOOKS RECEIVED.

College Physiography. By Prof. R. S. Tarr. Published under the editorial direction of Prof. L. Martin. Pp. xxii+837. (London: Macmillan and Co., Ltd.) 15*s*. net.

A Handbook of Vocational Education. By Dr. J. S. Taylor. Pp. xvi+225. (London: Macmillan and Co., Ltd.) 4*s*. 6*d*. net.

A Text-Book of Grasses. By A. S. Hitchcock. Pp. xvii+276. (London: Macmillan and Co., Ltd.) 6*s*. 6*d*. net.

The Royal Zoological and Acclimatisation Society of Victoria. Fiftieth Annual Report. Pp. 43. (Melbourne.)

New Zealand. Department of Lands and Survey. Report on the Survey Operations for the Year 1913–14. By E. A. Wilmot. Pp. 55+maps. (Wellington: J. Mackay.)

The Essex Institute. Historical collections. Vol. i. October. Pp. 289–404. (Salem, Mass.: Essex Institute.)

Some South Indian Insects and other Animals of Importance. By T. B. Fletcher. Pp. xxii+565. (Madras: Government Press.) 9*s*.

Vital Statistics Explained. By J. Burn. Pp. x+140. (London: Constable and Co., Ltd.) 4*s*. net.

A Study of the Circular Arc Bow-Girder. By Prof. A. H. Gibson and E. G. Ritchie. Pp. viii+80. (London: Constable and Co., Ltd.) 10*s*. 6*d*. net.

Imperial Department of Agriculture for the West Indies. Report on the Botanic and Experiment Station, Montserrat, 1913–14. Pp. 26. (Barbados.)

Reptiles and Batrachians. By E. G. Boulenger. Pp. xiv+278. (London: J. M. Dent and Sons, Ltd.) 16*s*. net.

Proceedings of the Liverpool Geological Society. Session the fifty-fifth. 1913–14. Part 1. Vol. xii. Pp. xiv+92. (Liverpool: Liverpool Geological Society.)

The Musical Faculty: its Origins and Processes. By W. Wallace. Pp. viii+228. (London: Macmillan and Co., Ltd.) 5*s*. net.

The Elements of Physical Chemistry. By Prof. J. L. R. Morgan. Fifth edition. Pp. xv+506. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12*s*. 6*d*. net.

A Handbook for Farmers and Dairymen. By Prof. F. W. Woll and others. Sixth edition. Pp. xvi+490. (New York: J. Wiley and Sons, Ltd.; London: Chapman and Hall, Ltd.) 6*s*. 6*d*. net.

Philosophical Transactions of the Royal Society of London. Series B. Vol. ccv. Experiments on Inheritance in Parthenogenesis. By W. E. Agar. Pp. 421–489. (London: Royal Society.)

Our Good Slave—Electricity. By C. R. Gibson. Pp. 246. (London: Seeley, Service and Co., Ltd.) 3*s*. 6*d*.

The Great Ball on which we Live. By C. R. Gibson. Pp. 249. (London: Seeley, Service and Co., Ltd.) 3*s*. 6*d*.

A First Course in Mathematics for Technical Students. By P. J. Haler and A. H. Stuart. Pp. vi+125. (London: University Tutorial Press, Ltd.) 1*s*. 6*d*.

Proceedings of the Aristotelian Society. New Series. Vol. xiv. Pp. 438. (London: Williams and Norgate.) 10*s*. 6*d*. net.

The Analysis of Sensations and the Relation of the Physical to the Psychical. By Dr. E. Mach. Translated by C. M. Williams. Revised and supplemented by S. Waterlow. Pp. xv+380. (Chicago and London: The Open Court Publishing Co.) 6*s*. 6*d*. net.

Essays on the Life and Work of Newton. By A. de Morgan. Edited by P. E. B. Jourdain. Pp. xiii+198. (Chicago and London: The Open Court Publishing Co.) 5*s*. net.

Trees and Shrubs Hardy in the British Isles. By W. J. Bean. Vol. i. Pp. xvi+688. Vol. ii. Pp. vi+736. (London: John Murray.) 42*s*. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 19.

ROYAL SOCIETY, at 4.30.—Note on the Circulation of the Atmosphere: A. Mallock.—The Origin of the Indo-Gangetic Trough—commonly called the Himalayan Foredeep: Sir S. Burrard.—Approximately Permanent Electronic Orbits and the Origin of Spectral Series: G. W. Walker.—Spectroscopic Investigations in connexion with the Active Modification of Nitrogen. IV.: A Band Spectrum of Boron Nitride: W. Jevons.—An Additional Note on the Production of High Permeability in Iron: Prof. E. Wilson.

CHILD STUDY SOCIETY, at 7.30.—Development of the Practical Imagination in Children: Prof. T. P. Nunn.

LINNEAN SOCIETY, at 8.—*Hydrilla verticillata*, Caspary, a New British Plant: A. J. Wilmott.—The Mosses and Hepaticæ of West Falkland Islands, from the Collections of Mrs. Rupert Vallentin: C. H. Wright.—The Thysanoptera of the West Indies: R. S. Bagnall.

INSTITUTION OF MINING AND METALLURGY, at 8.—Persistence of Ore in Depth: T. A. Rickard.

FRIDAY, NOVEMBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Effect of Vacuum on Steam-Turbines: G. G. Stoney.

MONDAY, NOVEMBER 23.

FARADAY SOCIETY, at 8.—Discussion: The Hardening of Metals. Introductory Address: Sir Robert Hadfield.—Some Recent Papers on Hardening and Overstrain in Metals, and the Bearing on these of the Author's Amorphous Theory of the Hardened State: Dr. G. T. Beilby.—The Influence of Allotropy on the Metastability of Metals and its Bearing on Chemistry, Physics, and Technics: Prof. E. Cohen.—The Hardening of Metals by Quenching: Prof. C. A. Edwards.—The Interstrain Theory of Hardening: Andrew McCance.—The Part Played by the Amorphous Phase in the Hardening of Steels: J. C. W. Humfrey.—(1) The Hardness of Solid Solutions; (2) A Note on Twinnings and the Martensitic Structure: Dr. C. H. Desch.—Metallic Filings: Dr. T. Martin Lowry and R. G. Parker.—The Hardening of Manganese Steel: Prof. H. M. Howe and A. G. Levy.—Instruments for Testing Hardness: H. L. Heathcote.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Mental Training of a Traveller: Viscount Bryce.

ROYAL SOCIETY OF ARTS, at 8.—The History and Practice of the Art of Printing: R. A. Peddie.

TUESDAY, NOVEMBER 24.

ZOOLOGICAL SOCIETY, at 5.30.—Exhibition of Tests of Arenaceous Foraminifera to Introduce a Discussion on the Interpretation of these Structures: E. Heron-Allen and A. Earland.—(1) A New Fossil Reptile from South Africa; (2) Notes from Some Carnivorous Therapsids; (3) *Eunotosaurus africanus*, Seeley, and the Ancestry of the Chelonia: D. M. S. Watson.—Polychæta from the N.E. Pacific: The Chætopteridæ. With an Account of the Phenomenon of Asexual Reproduction in Phyllochætopterus and the Description of Two New Species of Chætopteridæ from the Atlantic: F. A. Potts.

WEDNESDAY, NOVEMBER 25.

ROYAL SOCIETY OF ARTS, at 8.—The Supply of Chemicals to Great Britain and Her Dependencies: Sir W. A. Tilden.

THURSDAY, NOVEMBER 26.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Power Plant Testing: W. M. Selvey.

PHYSICAL SOCIETY, at 5.—Note on the Conduction of Electricity at Point Contacts: A. F. Hallimond.—Thermal Conductivity of Badly Conducting Solids: T. Barratt.

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THURSDAY, NOVEMBER 26, 1914.

THE RESPIRATORY FUNCTION OF THE BLOOD.

The Respiratory Function of the Blood. By Joseph Barcroft, F.R.S. Pp. x + 320. Cambridge University Press, 1914.) Price 18*s*. net.

THE title of this book gives but an inadequate idea of the scope of its contents. As the author states in the Preface, it is really an account of his "physiological ventures," and consists mainly of the researches undertaken by himself and his pupils, with slighter references to cognate work by other observers. The wealth of new facts and ideas which are here presented bears striking witness to the important part played in the advance of science by the discovery of a new technique. In practically all the investigations here presented it was necessary to determine the gaseous contents of minute quantities of blood or other fluids, so that the discoveries here made may be said to be the direct outcome of Haldane's invention of a method for the gaseous analysis of small quantities of blood—a method since perfected and elaborated to such an extent by the author of this book as to be identified with him. Armed with this new technique, he was able to attack a number of capital problems connected with the behaviour of oxygen in the blood, its uptake in the lungs, and the conditions of its utilisation by the tissues, with an ease and accuracy which previously was impossible.

This book, however, is not a mere reprint of Barcroft's physiological papers. In presenting his results, he wisely abandons the chronological for a logical order. In the first part he begins with a description of the physical and chemical characters of hæmoglobin and the determination of its combining power for oxygen in relation to its iron content. The constancy of the figures obtained in his latest experiments for oxygen capacity and iron content is regarded by the author as almost convincing proof that the combination is chemical in the strict sense of the term. He then discusses the oxidation curve of oxyhæmoglobin and the influence of temperature, electrolytes and acids on the curve. An important result arrived at is that the variations which have been described in the dissociation-curves in the blood of different animals may be ascribed to differences in the salt-content of the blood-corpuscles, which determine varying degrees of the aggregation of the colloidal hæmoglobin molecule.

In part ii. he proceeds to discuss what significance these facts have for the normal life of the animal. The question of the factors which determine the supply of oxygen to the tissues during rest and activity, involves difficult physiological experimentation on the exchange of gases between tissues and blood in voluntary muscle, heart, adrenals, pancreas, kidney and liver. From these results we are led on to another series in which the oxygen intake of the tissues is used as a criterion of the activity of the tissue-cells. In this way he is able to throw a welcome light on the nature of some of the phases of renal activity—activity of the cells being assumed as responsible for urinary formation when an increased flow of urine is associated with an increased uptake of oxygen by the kidney. A chapter on the metabolism of the blood itself (which, except in abnormal circumstances, is shown to be negligible) is followed by an account of the mechanism by means of which the supply of oxygen to the tissues may be regulated according to their needs. Prominent among these mechanisms is the local production of lactic acid and possibly other metabolites, which not only have a vaso-dilator action, so increasing the blood-flow through the part, but also, by their action on the dissociation-curve of hæmoglobin, favour the transfer of oxygen from oxyhæmoglobin to the tissues.

In the next chapter he describes a bold attempt made by him in conjunction with Verzar to determine the head of pressure driving oxygen from the blood to the tissues, using as his criterion the effect of variations in the oxygen-supply on the amount of this gas taken up by the tissues.

Under normal conditions, the blood has only a certain time to take up oxygen in the lungs and to give up oxygen in the tissues, viz. the duration of its transit through the capillaries of lungs and tissues respectively. An investigation of the rates of combination and dissociation of oxygen and hæmoglobin enables the author to show that the physical conditions which determine the form of the dissociation-curve outside the body are sufficient to account for the changes taking place within the body. This investigation naturally leads on to a discussion on the much debated question as to the mechanism of the uptake of oxygen in the lungs. A very impartial account is given of the views and investigations of Bohr, Haldane, Krogh, and Hartridge. His final conclusion is in favour of the view according to which the process is determined by the physical conditions existing in the lungs, though he points out that the question cannot be regarded as finally settled until the results obtained by Haldane and others on Pike's Peak have been reinvestigated by Hartridge's methods or have received some adequate explanation.

The third part of the work deals with the dissociation-curve of the hæmoglobin as an indicator of the reaction of the blood, and contains a wealth of interesting observations on the effects of diet, exercise, residence at high altitudes, and finally, certain pathological conditions associated with acidosis. The author is to be congratulated on the production of a book interesting not to physiologists only. The lively personal note of the narrative is a happy novelty in a physiological monograph, and will enable those of his readers who have not worked with him to appreciate and, in a measure, to partake of the genial optimism of the author. E. H. S.

GYROSCOPIC MOTION.

An Elementary Treatment of the Theory of Spinning Tops and Gyroscopic Motion. Second edition. By H. Crabtree. Pp. xv + 193. (London: Longmans, Green and Co., 1914.) Price 7*s*. 6*d*. net.

IN this, the second edition of Crabtree's admirable book, the text and paging of the first edition have been followed, but additions have been made where necessary, so that more recent developments may be dealt with. The first edition was noticed in NATURE (August 12, 1909, p. 182), so that it is not necessary to do more now than refer to the additional matter. The two monorail systems of Brennan and Schilowsky are illustrated and described. It may be mentioned that each of these derive their stability from a gyrostatic system, the action of which is independent of the forward motion of the car, so that the stability exists whether the car is moving forwards or backwards or is at rest, and in this respect differs entirely from the systems more recently invented by Dr. Gray.

There is a full discussion of the Anschütz gyro compass, but this is the same as that which is given in the manual published by Messrs. Elliot Bros., having been translated for them by the author and his colleagues. The writer of this notice hoped to have found also a description of the Sperry gyro compass, which differs in certain respects very materially from its forerunner, the Anschütz. A discussion by the author of the relative merits of the two systems where they differ would have been very illuminating. Unfortunately, this instrument is not mentioned. Other matters ably dealt with in the appendices are the swerving of golf-balls and the drifting of rifled projectiles, both subjects on which amazing nonsense is often written.

There is a statement in the earlier part of the book on the skidding of motor-bicycles, with which the present writer does not agree. Seeing that the back tyre is being constantly impelled to slip longitudinally on the ground by successive explosions in the cylinder, more especially where a rigid chain drive is employed, or where the flywheel of the engine is insufficient, and that a longitudinal slip will start a side slip, there is abundant cause for the side-slipping capacity of these machines, without looking to more subtle causes. Briefly, the author explains that in consequence of the gyrostatic action of the flywheel a transverse couple must be applied in order to make the flywheel's plane of rotation change when the machine is describing a curve. In order to apply this, the rider and machine must lean over to a very small extent more than would be necessary otherwise. So far so good; the transverse couple is caused by the weight of the whole combination of machine and rider acting vertically downwards, and a corresponding reaction at the road acting vertically upwards, and the arm of the couple is the excess of the horizontal distance between the centre of gravity and the wheel base due to the extra leaning. The transverse force on the road, which alone gives rise to side slip, is unchanged.

It is satisfactory to find that there is a sufficient demand for a book of such thoroughness as this to have called for a second edition in a comparatively short time. C. V. BOYS.

BRITISH FLOWERING PLANTS.

British Flowering Plants. Illustrated by Three Hundred Full-page Plates, reproduced from Drawings by Mrs. Henry Perrin. With Detailed Descriptive Notes and an Introduction by Prof. G. S. Boulger. Vol. i. Pp. xlv + plates. (London: Bernard Quaritch, 1914.)

MRS. PERRIN'S book, of which the first volume is before us, is essentially a book for the use of ladies and those who take a dilettante interest in botany and flowers. It is unfortunate, therefore, that it is of such a weight that its presumed readers may scarcely have the strength or energy to handle the bulky tomes.

Not only are the plates heavily loaded with plaster of Paris, but the large quarto pages of text are of almost equal solidity. If the contents of the book were of any scientific interest or formed a real addition to knowledge, the great bulk of the volume would be a matter of sincere regret; we cannot, however, foresee any particular use for the book, except that its handsome back may adorn the shelves of an expensive library, and can only deplore that the money expended on this production could not have been put to some object of definite botanical value.

The paintings, which afford the *raison d'être* of the book, are on the whole good, though in many cases a more artistic arrangement of the material might have been achieved. Some pictures, as that of the snowdrop, for instance, are unworthy of the book. To the botanist the pictures are of little value, owing to the absence of an analysis of the parts of the flower and fruit, and this defect is especially noticeable in the case of the plates of the bulrush and Luzula, which give no indication of the structure of the flowers. It may be urged that such details are relegated to special plates, but even then they are so poorly executed and often on so small a scale as to be of little assistance. It is unfortunate that the artist, who undoubtedly possesses considerable skill and has bestowed so much labour on her drawings, had not sought the best advice as to the way in which she might have made her pictures of value.

The notes supplied by Prof. Boulger are full of useful information and make pleasant, if not very strenuous, reading. We doubt, however, owing to the bulk of the book, if they will receive very serious attention. He has collected together a good deal of curious and out-of-the-way information under the different plants which it is well to bring to the notice of students and those interested in flowers. In addition to the ancient lore the correct naming of the plants is fully treated, and a considerable amount of recent work of interest is incorporated as occasion demands.

Information about the habitats and general condition of life of the different plants figured is also given. In the introduction a useful outline of general floral morphology and classification is to be found, and the plates with their pages of text follow. The plants figured in the volume include the British conifers, certain monocotyledons, the willows, oak, beech, and allied trees, the nettles, Polygonaceæ, Caryophyllaceæ, and a few others.

PHYSICAL CHEMISTRY.

(1) *The Theory of the Solid State.* Based on Four Lectures delivered at University College, London, in March, 1913. By Prof. W. Nernst. Pp. viii+104. (London: Hodder and Stoughton, 1914.) Price 2*s*. 6*d*. net.

(2) *Lehrbuch der physikalischen Chemie.* By Dr. K. Jellinek. Band i. Die Lehre von den Aggregatzuständen, Teil I. Pp. xxxvi+732. (Stuttgart: F. Ende, 1914.) Price 24 marks.

(3) *Complex Ions in Aqueous Solutions.* By Dr. A. Jaques. Pp. vi+151. (London: Longmans, Green and Co., 1914.) Price 4*s*. 6*d*. net.

(1) THOSE who had the opportunity of hearing Prof. Nernst deliver his short course of lectures at University College, London, on the Quantum Theory as applied to the solid state of matter will welcome this somewhat belated publication. The book is a masterpiece of lucid condensation, covering as it does in a small number of pages the whole range of modern work on the thermal properties of solids. The limitations of the Dulong-Petit generalisation are briefly discussed. The necessity for the introduction of some new hypothesis in place of equipartition is made clear, and the fortunate application of Einstein of the Planck quantum concept to the heat capacity of vibrating atoms is shown to point the way to a new understanding of the baffling problem of the solid state. The Nernst-Lindemann empirical modification of the Einstein formula is touched upon, and later the more theoretically significant expression of Debye.

Whilst fully realising the great progress which has been made by the introduction of the quantum theory to the thermal properties of solids (and gases and liquids for that matter), it would be idle to pretend that everything is at present on a sure and certain basis. As a matter of fact nearly every stage bristles with assumptions, and although the general trend is certainly in the right direction, not a few of the assumptions are mutually conflicting. A science in this state is, however, just at its most attractive stage, and the number of investigations cited as references in the book are ample evidence of the interest which the subject has awakened, especially in Germany.

An important feature of the book is the good account of the experimental methods employed in the Berlin laboratory for the determination of specific heats, especially at very low temperatures. Perhaps the most interesting section is that entitled "General law respecting the behaviour of solid bodies at very low temperatures," in which a most suggestive account of present and future problems is given on such subjects as thermal expansion, compressibility, conduction of heat and electricity, thermal e.m.f's, and magnetic susceptibility. It would seem that before long the subject of thermal and electrical conductivity of solids will be a region of controversy between the electron view and the quantum view—which, it is to be hoped, will result in a clearer physical conception of what the quantum really is. It is noteworthy that no mention is made of Sommerfeld's views.

There is no question that during the next decade at least, the most active investigation in theoretical physics and chemistry will consist in the further extension and application of the quantum theory, hence the significance of the present publication which is a most excellent epitome of the subject (so far as it refers to solids), by one who is himself one of the pioneers in its development.

(2) The bulky volume before us represents vol. i. of a Text-book of Physical Chemistry to be completed in four volumes. The author, Dr. Karl Jellinek, has indeed no light task before him in thus undertaking a work which is intended to be an Ostwald Lehrbuch brought up to date, and written in even greater detail than its prototype. Dr. Jellinek's repute, however, as an investigator and a writer—it seems only the other day that a large and very valuable work on a branch of physical chemistry appeared from his pen—entitles us to expect that the present book when completed will succeed in fulfilling the author's expectations. As is stated in the preface, stress is laid (though not unduly) upon the physical aspect of the subject, and the fact that two large volumes are to be devoted to the consideration of states of matter (in the widest sense) is evidence of this.

Vol. i commences with a very full account of literature sources (text-books of all kinds and journals) this being followed by an introductory chapter dealing with the principles of the kinetic theory and thermodynamics. Next comes the subject matter proper, beginning first with an account of the gaseous state (pp. 160–431), transition from gaseous to liquid (pp. 432–468), and the liquid state itself (pp. 469–711). In vol. ii., which is promised shortly, the liquid state will be still further considered, and after that the solid state and dilute solutions. As illustrating the extent of detail one may quote the table of contents of the principal chapter included in the first subsection (dilute gases) of the section dealing with the gaseous state in general, viz., the Maxwell distribution law, rigid deduction of the gas law, degrees of freedom, rotation of gas molecules, vibration of atoms in gas molecules, law of equipartition of energy between degrees of freedom inside a molecule, theory of the specific heat of dilute gases. The liquid state is considered in equal detail. A book written authoritatively as this undoubtedly is, and on this scale of minuteness, is bound to become an indispensable work of reference for all physical chemists.

(3) Dr. Jacques's monograph on complex ions in aqueous solution is an eminently useful publication. Five chapters are devoted to the principal methods of detecting and determining complexes, viz., the chemical method, distribution method, ionic migration method, solubility method, and e.m.f. method. The remaining chapters deal with applications of these methods to various cases, notably the complex mercury salts, ammoniacal solutions of metallic salts, salts of cobalt and copper (including Fehling's solution), equilibrium between metallic ions at different degrees of oxidation, polyiodides and sulphides (the latter being particularly well treated). The appendix contains a brief account of the hydrate theory and a general scheme for treating complexes theoretically. Great stress is laid upon the significance of equilibrium constants and their numerical evaluation. The book can be warmly recommended.

W. C. McC. L.

OUR BOOKSHELF.

Agriculture in the Tropics. An Elementary Treatise. By Dr. J. C. Willis. Second edition, revised. Pp. xvi+223. (Cambridge University Press, 1914.) Price 9*s.* net.

AGRICULTURE resolves itself mainly into a combination of the four factors, crops, soil, labour, and climate. Of these, in tropical countries crops are quite the most interesting on account of their diversity and high economic importance. There is therefore ample justification for the large amount of space—nearly half the volume—devoted to descriptions of the principal agricultural products; even then it is only possible to present general outlines of cultivation and preparation. The author draws largely upon his long and varied experience in Ceylon, also upon his personal knowledge of agriculture in Malaya and India. Soil problems do not receive much discussion; there is, for instance, little or no reference to modern soil science and we should have expected a fuller account of the practice and details of green manuring. The labour factor, on the other hand, especially peasant agriculture, is discussed very fully in the last seventy pages, with the object of describing native methods and considering how their efficiency may be increased. There is much soundness in the general opinions enunciated that before improvements are attempted, due regard must be had to the peasants' environment and scruples. Co-operative seed stores and education by school-gardens are advocated as the most hopeful remedial measures.

The value of the book lies largely in the original source and nature of the information supplied, based as it is upon intimate knowledge gained by many years' administration as director of the Botanic Gardens in Ceylon. The first edition of the book was published nearly five years ago.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Fifth edition, entirely re-written and enlarged. Vol. ii. Pp. xiv+944. (London: Macmillan and Co., Ltd., 1914.) Price 25*s.* net.

THE second volume of this well-known work deals with the commercial preparation of the raw materials used in the oil, fat, and wax industries, and with the methods of preparing and examining the individual oils, fats, and waxes. For the fifth edition a competent editor appears to have been found in Mr. G. H. Warburton, who was associated with the late Dr. Lewkowitsch's analytical practice for a number of years. The work as a whole was reviewed in these columns on the occasion of the previous issue, and its general plan remains unchanged, though the matter has been re-written and many additions made. These include, in the volume under notice, a number of hitherto unpublished results obtained in the author's laboratory, and also data respecting certain oils such as those from perilla seed and rubber seed which, though little known in this country at present, may perhaps prove of commercial importance in the future. There are also some revisions of the older values for the physical and chemical "constants" in cases where the adoption of improved processes for the preparation of oils and fats has rendered the earlier figures obsolete. The volume, in fact, appears generally to have been brought well up to date, and users of the work will find the new edition increasingly serviceable.

Flintshire. By J. M. Edwards. Pp. xi + 172. *Peebles and Selkirk*. By G. C. Pringle. Pp. x + 149. (Cambridge University Press, 1914.) Price 1*s*. 6*d*. net each.

ATTENTION has been directed on several occasions to the attractiveness and utility of the Cambridge County Geographies. These recent additions to the series have been bound in a new form, which makes them very convenient for use as guide books, a purpose they will be found to serve admirably, without in any way interfering with their popularity as interesting supplements to geography lessons in schools. Both authors may be congratulated upon maintaining the high standard set in previous volumes.

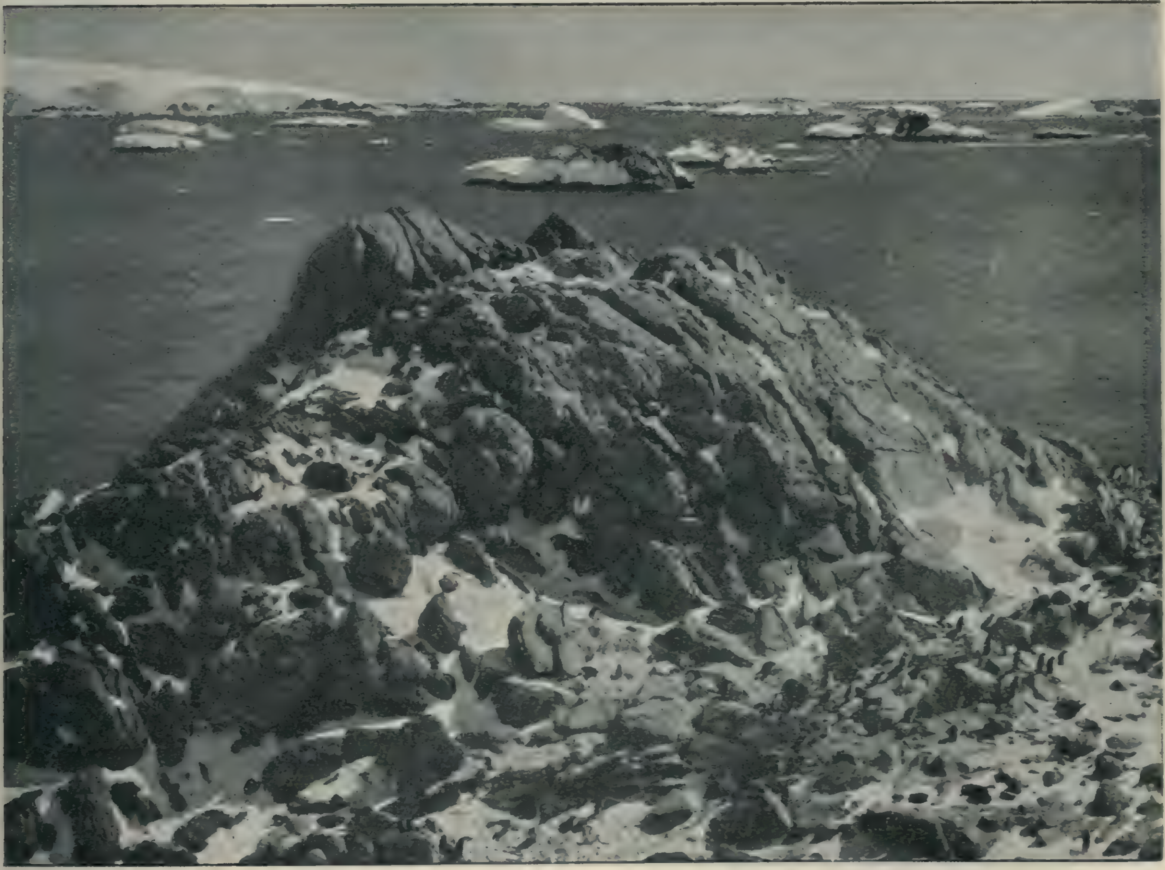

FIG. 1.—A view of the islets off the coast of the mainland looking west from Stillwell Island, Adelie Land. From the *Geographical Journal*.

THE AUSTRALIAN ANTARCTIC EXPEDITION.

THE scientific value of the Australian Expedition, described by Sir Douglas Mawson in the September number of the *Geographical Journal*, though obtained by great toil and hardships, which were almost fatal to the leader and led to the tragic deaths of two of his companions, promises to be very great. Before this expedition, as the maps show, little was certainly known about the Antarctic continent for quite 70° of longitude, from some distance west of Cape Adare to the winter quarters of the *Gauss* in 1902–3. The geography of this, as the maps show, has now been ascertained by adventurous and laborious sledge journeys from the two bases occupied by Mawson's expedition, and the following are its main results.

Macquarie Island, a link between Tasmania and South Victoria Land, on which a party was left in charge of the wireless telegraph station, has been surveyed and its natural history studied. Here, and on the mainland, rare seals, fish, and numerous birds were obtained, with a large collection of eggs, most of which were previously unknown. Sounding and dredging were carried on, with excellent results, in the sea between Australia and the Antarctic continent. The rocks of the mainland appear to be largely crystalline, probably Archæan, with some sedimentaries (among which the Beacon Sandstone apparently occurs), containing coal and carbonaceous shales. Capping them are great masses of columnar dolerite (Fig. 1).

The climate of all the region explored seems to be even worse than that in the Ross Sea district. Blizzards are almost incessant, even in summer: the average annual velocity of the wind being 50 miles an hour, and it often rises to above 100 miles. In winter the air is full of particles of ice, and the electricity generated is so great that hands, noses, and projecting parts of the clothes show pale gleams like St. Elmo's fire.

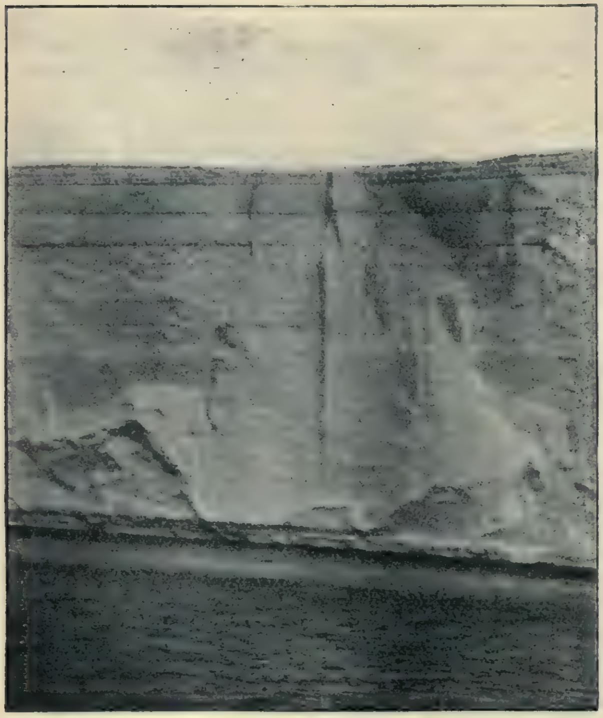

FIG. 1.—The face of the Shackleton Shelf. Each band represents an annual snowfall addition. From the *Geographical Journal*

This portion of the Antarctic continent seems to be less mountainous than South Victoria Land, but its snowfields rise inland to heights of from 2000 feet to above 4000 feet; one of the exploring parties attaining in that direction an elevation of nearly 6000 feet. An ice barrier, like the well-known one in Ross Sea (named Shackleton's Shelf) defends most parts of the coast, and gives a still more conspicuous instance than that affords of projecting tongues of ice formed by the huge land glaciers, which force their way through the barrier, and protrude many miles, in one case quite sixty, out to sea. In other words the barrier exchanges the piedmont for the more normal glacier type. But in other respects the history of this floating ice corresponds with that of the Ross Sea Barrier. Its upper part, probably all visible at its extremity, is not land-ice, but stratified frozen snow, as shown in Fig. 2, formed by the accumulated annual snowfalls: the great part of the original land-ice having been melted off by the sea-water. Thus the rock *débris* incorporated in the lower part of that ice (and in these regions there cannot be much in the upper) must be distributed over the sea bottom—a fact of which the advocates of the terrestrial origin of all boulder clays will do well to take cognisance. Thus a fine piece of work—geographical, meteorological, botanical and zoological—has been accomplished, and Australia, as in the case of the Funafuti boring, has done a most notable service to science.

T. G. BONNEY.

DETERIORATIVE CHANGES IN WINE.[1]

SINCE the time when Pasteur, in his "Études sur le Vin," described a certain bitterness sometimes occurring in wine (*Maladie de l'amertume*) as being apparently due to a specific micro-organism, most of the forms of deterioration which wine undergoes have been recognised as due to biological action. Thus the *Kahmigwerden*, the *Essigstich*, and the *Milchsäurestich* of German writers, the *poux* and the *graisse* of French œnologists, are ascribed to the undesirable activity of various bacteria, moulds, and yeasts. Sourness, for example, is often due to acetic acid produced by the ferment *Mycoderma aceti* from the alcohol of the wine; whilst another mycoderm (*M. vini*) is believed to produce faulty wine by attacking the cream of tartar and albuminous extractive matters.

Some of the faults which may develop in wine, however, are attributable to causes not primarily biological. A certain kind of mustiness, for instance, is ascribed to the effect of a malodorous essential oil. The presence of iron salts, again, has been recognised as a necessary condition for the appearance of a particular kind of turbidity—the *casse ferrique*—which in certain circumstances may affect white wines. With this phenomenon oxidation processes are known to be associated, and the intervention of an oxidase, transferring oxygen from the air to substances in the wine not directly oxidisable under ordinary conditions, has been suggested to account for the results observed.

Dr. Horace Brown has studied at considerable length a variety of *casse* to which the white wines of the Cape are particularly liable. Although the wines may have been bottled perfectly bright, they have a tendency to become cloudy and to throw out a light deposit. This tendency is accompanied as a rule by more or less darkening of colour, and by modifications in the flavour and odour which are very characteristic. Even before any *casse* or "break" (cloudiness) is observable in them, wines undergoing this change acquire an "earthy" odour or *terroir;* and simultaneously a distinctive bitter flavour of a greater or less intensity is developed. These faults—cloudiness, earthy odour, bitterness, and modification of colour—may exist in different degrees, but are apparently all related to a common cause; and Dr. Brown's experiments indicate that this cause is not to be sought in the action of micro-organisms. The malady is conditioned by purely chemical changes. Moreover, it only occurs when the wine is in contact with air, or with free oxygen derived from some such sourc as hydrogen peroxide.

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[1] "An account of some investigations on the White Wines of South Africa: an Œnological Study. By Horace T. Brown. *Journ. Inst. of Brewing*, vol. xx, No. 5.

Naturally one of the first things to ascertain in studying the malady was the true character of the suspended matter forming the turbidity. Under the microscope it was found to consist of amorphous aggregates of minute, roughly-spherical particles, which were readily stained by Coupier's blue, dissolved easily by caustic alkali, and also, though with some difficulty, by dilute acid. Except in this last point the deposit resembles the amorphous matter which separates from beer in certain circumstances, and which has been shown by Dr. Brown himself to consist mainly of a combination of tannic acid with albuminoids. The actual amount of the deposit necessary to give a distinct turbidity to wine is relatively very small: in one instance the weight of the substance when dried was only 6·4 milligrammes per litre of wine. The organic portion of the deposit contained nitrogen equivalent to 55·9 per cent. of albuminoids. When incinerated, the dry substance of the deposit yielded 12·9 per cent. of inorganic material, four-fifths of which was ferric oxide. In fact, a striking feature about all the deposits in this kind of *casse* is the comparatively large proportion of iron which they contain.

It was found, further, that an essential factor in the production of *casse* was the presence of a little iron in the *ferrous* state. This apparently acts as a carrier of atmospheric oxygen to certain oxidisable substances in the wine, much in the same way as traces of ferrous salts behave in the well-known "Fenton" reaction.

Systematic experiments showed not only that air and ferrous salts are necessary, but that certain oxidisable substances in the wine are also required. Of these the most notable is tannic acid; and the author concludes that the material forming the turbidity or deposit is in fact "a colloidal combination of iron with products derived from the limited oxidation of tannins and certain wine-albuminoids." This does not, of course, tell us all that it is desirable to know about the deposit and the conditions of its formation. The question of the nature and amount of the nitrogenous substances in the wine, and the part they play in the production of the changes, has still to be investigated. As the author remarks, wine-making has its own particular "nitrogen question," and it is at present virgin ground.

Good evidence was obtained to show that the oxidising agent concerned is not a vegetable oxidase. Freshly expressed grape juice contains no oxidase, though it may dissolve some from the grape skins if left in contact with them. In any case there appears to be no connection between the occurrence of oxidase and the *casse ferrique.* The immediate cause of this deterioration is the alternate reduction and oxidation of iron, with consequent transference of oxygen to the changeable tannins and other constituents of the wine.

Now if this is true, it points the way to preventive and remedial measures. One such measure, obviously, is to avoid so far as possible the must or wine taking up iron at any stage of the making or storing. If, however, an excess of iron cannot be helped, it would be expected that the addition of a reducing agent to maintain the iron permanently in the ferrous condition would prevent the occurrence of the malady. This was found to be so, the action of sulphites in this respect being very pronounced. Again, since tannic acid is one of the essentials, its removal should be beneficial; and in fact the addition of casein to the wine has a favourable influence which is attributed to an adsorptive separation of tannin by the casein. As regards the other essential condition—the presence of air—the author recommends that aeration of the wine should be guarded against during the maturing and bottling operations, and that the bottles should be completely filled. In this connection it is noted as unfortunate that the visitor to the Cape generally makes the acquaintance of South African wines for the first time on the ship going out. The bottles are frequently not completely filled, and this, with the alternations of temperature and the swing of the ship, helps to produce the malady in question, especially in the more delicate white wines.

The faults mentioned are so common in the white wines of South Africa that the author at one time regarded them as due to some fundamental causes, such as soil and climate, which were beyond control. But the occurrence of perfectly "clean" wines, the production of such wines under his own auspices, and the results of the investigation which has been outlined, have altered this view. Not Providence, but the producer, is responsible—or at least, the producer and the merchant must share the responsibility.

The scientific study of this question made by Dr. Brown, necessarily incomplete though it is, has given definite knowledge where hitherto information has been vague or absent, whilst the practical application of this knowledge indicates the direction in which remedial measures are to be sought. It is to be hoped that the author will be able to extend the research to the "nitrogen question" already mentioned, and with equally definite results.

C. SIMMONDS.

A PHYSIOLOGICAL PUZZLE.[1]

WHAT the magicians did in ancient days before Pharaoh in the way of turning sticks into snakes has often been done since, or its converse of turning snake into stick, but it remains in great measure a physiological puzzle. If the cobra in its threatening attitude be deftly caught behind the head and gently pressed, it soon becomes stiff, and will remain so for a considerable time, either coiled up or drawn out straight. It has passed into the strange state of animal hypnosis. In 1646 the Jesuit father, Athanasius Kircher, described the famous experiment, "de imaginatione gallinæ." He laid a hen on the table, held it firmly for a little, and drew a chalk line in front of its eyes, with the result that it remained as if in katalepsy. Czermak showed in 1872–3 that this could be done with many birds, and that the chalk line was quite unnecessary. The veteran entomologist, Fabre, tells us that he and his school companions used to put a whole flock of turkeys to sleep with their heads tucked under their wings. Animal hypnosis can also be induced in mammals (guinea-pig, rabbit, mouse, squirrel, bat, dog, cat), and this is usually effected experimentally by fastening them to a board and turning this suddenly upside down. Frogs are readily susceptible, and newts will also submit.

In backboned animals the state of immobility is scarcely known except in artificial conditions, and can scarcely be of much importance in life. It is otherwise, however, when we pass to the analogous "death-feigning" or katalepsy in certain beetles, water bugs, stick-insects, and spiders. The immobility occurs in natural conditions, and it seems often to save the life. The case of the female Galeodes is of special interest, since the more than recalcitrant female passes into a convenient hypnosis when she is suddenly seized by the weaker male. This may be induced artificially in the sexually mature female by gripping her suddenly in the dorsal region of the abdomen with a pair of fine forceps and raising her from the ground. She remains quite passive until she is restored to earth. It is very interesting to note that older females, who have paired, do not pass into katalepsy, but turn fiercely on the forceps. In the same connection it is worth recalling that when we lift a shore-crab, holding the shield between finger and thumb, and wave it in the air, it becomes immobile, but the two sexes dispose their limbs in different ways, the female bending them in over the abdomen, as if protecting the eggs. The familiar case of the fresh-water crayfish is interesting, because the creature does not pass suddenly into hypnosis, but usually resists for a considerable time. It may be fixed in any position of equilibrium—on its head, on its back, or even in its normal pose. The stick-insect, Dixippus, which feeds at night, normally assumes its protective immobile attitude under the stimulus of light, but a mechanical stimulus also serves. Schmidt has recently shown that the insect can be fixed in any grotesque attitude for hours on end. It has been shown that the transition from one state to the other can in this creature be effected almost in a moment.

In a case like the stick-insect we cannot but regard the kataleptic habit as of protective value; it adds to the safety which the protective form and the protective colour also help to secure. The creature behaves as if it knew, for it almost always disposes itself parallel to the twig to which it is attached. Schleip also points out that when it lets go on being touched, the elongated, straight disposition of the appendages makes it easier for it to slip down among the twigs. In Galeodes, as we have noted, the sudden passivity of the female is of importance in reproduction, and a similar phenomenon has been observed in the female octopus. In many cases, however, it seems quite impossible to maintain that the katalepsy is protective at all. Thus Fabre notes that *Scarites buparius,* one of the large ground-beetles, which a shake sends into a lasting katalepsy, is voracious, well-armoured, nocturnal, and unpalatable. What has it to do with "death-feigning"? Cases of this sort suggest that the kataleptic tendency may be simply a concomitant of a certain type of nervous constitution, and that it is only occasionally turned to advantage.

According to Mangold, the characteristics of human hypnosis are: that it is a sleep-like state, induced by suggestion; that it implies a rapport between the hypnotiser and the patient, and an increased amenability to suggestion; that it involves an inhibited power of locomotion and of "righting" the body, a change in muscular tonus—from initial increase to somewhat sudden decrease—and a change in sensitiveness which may amount to anæsthesia and analgesia. Suggestion is a psychically-conditioned effect, for which the physiological stimulus seems to be inadequate. Little is known in regard to the hypnosis of the highest animals, like dogs and cats, the amenability of which to human influence is well known, but in ordinary cases it may be concluded, according to Mangold, that animal hypnosis differs from man's in the absence of the suggestion, the rapport, and the deeper stages. It may be induced in animals without a cerebrum, which indicates that the psychological factor is unimportant. Physiologically considered, however, the more typical forms of animal hypnosis must be ranked beside human hypnosis, and studied in this light.

The resemblances are many. The sleep-like state is induced in man by suggestion or psychical inhibition, in animals by mechanical inhibition, but in both cases sensory stimuli may assist. These stimuli may be optic (fixing the gaze on some object), or tactile (stroking the skin), or otherwise. Sometimes an absence of wonted stimuli may induce the state, as in the case of absolute silence. The awakening may be brought about by sounds, shaking, currents of air, or electric shocks; or it may occur spontaneously. There is great specific and individual diversity in susceptibility; the easier the inducing of the hypnosis, the deeper and more lasting it is. The muscular tonus changes characteristically (now great stiffness and again "waxy flexibility"); resistance to fatigue is increased. Reflexes are to some extent affected by the altered tonus. Sensitiveness to touch and to pain may be greatly lessened, and operations may be performed during hypnosis. But the senses remain awake, and, except in the deeper phases in man, memory partly persists. Anæmic symptoms are sometimes observed, but there is no regular alteration in the everyday functions, such as the beating of the heart or the respiratory movements. Since animal and human hypnoses agree in all these respects, Mangold has confidence in his thesis that they are thoroughly analogous phenomena.

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[1] "Hypnose und Katalepsie bei Tieren im Vergleich zur menschlichen Hypnose." By Ernst Mangold. Pp. 82+18 figs. (Jena: Fischer, 1914). Price 2.50 marks.

Finally, in his interesting study, he proposes a classification :—

1. Experimental hypnosis induced by psychical inhibition (suggestion hypothesis): (*a*) in man, and (*b*) perhaps in some of the highest mammals;
2. Experimental hypnosis induced by mechanical inhibition: (*c*) in mammals, birds, reptiles, and amphibians, and (*d*) in crustaceans and insects;
3. Natural hypnosis induced by "biological" stimuli: (*e*) death-feigning in crustaceans and insects, and (*f*) katalepsy in stick-insects.

DEEP SEA EXPLORATION.[1]

IN their book entitled "The Depths of the Ocean," which was noticed in NATURE of October 24, 1912, the late Sir John Murray and Dr. Hjort gave a general account of the expedition of the *Michael Sars* in the North Atlantic, and discussed the most striking results which had been obtained. The material collected had, however, been only partially worked out when that book was published. The more detailed scientific reports are now to be issued in a series of volumes containing memoirs by different specialists. The present volume is the first of these reports to be published, and deals with some of the zoological results of the expedition.

The Cephalopoda are described by Prof. C. Chun. A large number of species were obtained, several of which are described as new, but perhaps the most interesting feature of the collection is the series of early stages of *Spirula australis*, Lamarck. These were obtained in the neighbourhood of the Canary Islands, where they were taken in plankton nets. There were three larval stages, of which the youngest is 6 mm. long and has five chambers projecting at the posterior end of the body; the next has six visible chambers, and the third is 9 mm. long with seven chambers. In addition to these larvæ, young stages with dorsal mantle lengths of 12 mm., 16 mm., 18 mm., 23 mm., and 26 mm. respectively were obtained. Excellent figures of the external appearance of these larvæ and young stages are given. Their internal anatomy has not, however, yet been examined. The memoir ends, to use Prof. Chun's own words, "with the description of a new and wonderful type of Cirroteuthidæ, which may probably be counted among the most valuable spoils of the expedition. The specimen is a perfectly gelatinous, semi-transparent cephalopod, the fragility of which recalls that of a ctenophore." To this interesting animal, which is fuly described and well-figured, the name of *Cirrothauma Murrayi, n. gen.* and *n. sp.* is given.

The Cirripedes are described by the late Dr. P. P. C. Hoek, the forms obtained being all previously known, and Dr. Kr. Bonnevie deals with the Pteropods. Dr. Bonnevie's memoir contains an elaborate and useful discussion of the two species *Limacina balea* and *L. retroversa*, about which very great confusion has existed. Dr. Bonnevie shows clearly that the two forms are distinct, and he describes the limits of variation in certain characters of the shell of each species.

The Scyphomedusæ, Pennatulacea, and Hydroida are treated in three memoirs by Dr. Hjalmar Broch. It is to be regretted that Dr. Broch commences his first paper by an unfortunately worded attack upon the scheme of plankton nomenclature which was introduced a good many years ago by Dr. G. H. Fowler. The "epiplankton" of Fowler is certainly not the same as the "meroplankton" of Haeckel, as Dr. Broch seems to think, but is that part of the "holoplankton" which lives between the surface and 100 fathoms. This is clearly explained in Steuer's "Planktonkunde" (p. 370), to which work Dr. Broch refers for support. Steuer himself would seem to have adopted Apstein's term "passiv limnetische Planktonten," for the forms in fresh water which attach themselves to other organisms, remarking that these forms *have been called* "epiplanktonic." In one instance (p. 616) only, so far as his index shows, he uses the term in the latter sense without qualification, and he nowhere gives any indication as to when or by whom it was first introduced. If it is shown that the word "epiplankton" had been employed in another sense previous to its use by Fowler, then it may be necessary to find a new term for what Fowler calls "epiplankton."

In the *Michael Sars* collections Dr. Broch finds ten species of Scyphomedusæ, of which two, *Nausithoē atlantica* and *N. globifera*, appear to be new, five species of Pennatulida and a considerable number of hydroids obtained partly from drifting sea-weed and partly from hauls of the young-fish trawl. An interesting figure, drawn by the artist on the *Michael Sars*, is given, in which an attempt has been made to represent the appearance of the Pennatulid *Umbellula güntheri* when in a state of phosphorescence.

The Murænoid Larvæ, which formed a most important collection, are described by Einar Lea. The general results as regards the occurrence of the earliest larvæ of the common eel in mid-Atlantic, in the region south-west of the Azores, were first described by Dr. Hjort in the pages of NATURE (November 24, 1910), immediately after the return of the expedition. In the present memoir the preliminary description then given is extended, and a large number of other eel larvæ in various stages of development are described. An attempt is made, with considerable success, to correlate the distribution of the murænoid larvæ with the hydrographical conditions (salinity, temperature, and depth) at the positions where they were captured.

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[1] Report on the Scientific Results of the *Michael Sars* North Atlantic Deep-sea Expedition, 1910, carried out under the Auspices of the Norwegian Government and the Superintendence of Sir John Murray, K.C.B., and Dr. Johan Hjort. Vol. iii., part 1, Zoology. (Published by the Trustees of the Bergen Museum.)

The last memoir is a short paper by Ørjan Olsen on the Pycnogonida, of which *Collossendeis michaelsarsi* and *Nymphon longituberculatus* are new, and are described in detail with good figures.

The volume is produced in excellent style, and the illustrations are without exception well done. The whole series of reports, it is explained, will comprise five volumes, the total cost of which will not exceed 20*l*. It is added that separate volumes will not be offered for sale, an arrangement which will probably seriously curtail the distribution, and consequently the usefulness, of the work.

E. J. ALLEN.

BELGIAN PROFESSORS AND STUDENTS AT CAMBRIDGE.

UNIVERSITIES always have had small beginnings, and the attempt to build up an informal Belgian university at Cambridge is no exception to the rule. After the fall of Louvain, Cambridge formally asked the university authorities of that town to bring over such students and professors as could come with the view of carrying on their studies here, so that the continuity which every university greatly values should not be interrupted. It was the time of the Papal election, and Cardinal Mercier, the head of the University of Louvain, was away in Rome, and there was a good deal of difficulty in getting into touch with him, and before anything was settled Liège had also fallen. The hospitality of Cambridge was then extended to the university of that town. After some negotiations it was found impossible for either university to transfer its corporate and official existence beyond the Channel, and it therefore became impossible to attempt to organise official courses of study, to institute examinations, or to grant diplomas.

This, however, has not prevented the formation of unofficial courses, combining so far as possible systematic instruction on the lines of the Belgian universities with the individual requirements of refugee students and the restrictions of a necessarily rather incomplete Belgian teaching staff. The necessity of some kind of organised occupation was fully recognised, both by the professors assembled at Cambridge and by the Belgian Government. Cambridge hoped to take some part in protecting the students from the demoralising and dangerous consequences of enforced idleness —a condition likely to be prolonged for months even after the conclusion of the war, owing to the devastation of houses and property in the Belgian seats of learning.

The presence of professors representing almost all faculties has rendered it possible to form courses in several of them, though no one faculty can boast a quite complete organisation. The faculties of philosophy and letters (so important to a large section of students, viz., those who in ordinary conditions would just have entered upon their university education), and those of law and of engineering are so far the most favourably placed. Each of them is represented by several professors. Those who act as secretaries for their respective faculties are Prof. Carnoy (Louvain) for philosophy and letters, Prof. Dupriez (Louvain) for law, and Prof. Breithof (Louvain) for engineering. The faculties of medicine and science, represented by Prof. van Gehuchten (Louvain) and Prof. Colson (Louvain) respectively, are at present being organised, and the number of their students is constantly growing. It is hoped to organise the teaching in these faculties more completely with the assistance of professors who may feel disposed to take up their residence in Cambridge and to take their share in the direction of studies. A fairly large number of students of the commercial and consular sciences has also assembled, and as the published list of lectures shows this faculty is doing well.

It should also be mentioned that for each Belgian faculty "in being" there is a corresponding British committee consisting of a president and a secretary, whose pleasant duty it is to arrange lecture-rooms, libraries, laboratory facilities, etc., for both the Belgian professoriate and the Belgian students.

Cambridge has indeed room for far more Belgian students than she is likely to receive. Many of the colleges are more than half empty, and the Lodging-House Syndicate estimate that there are a thousand sets of students' rooms vacant in the town. The stout-hearted landladies are very patriotic, and they are willing to give board and lodging to Belgian students at the rate of 15*s*. to 20*s*. a week, which can scarcely be very remunerative to these stricken ladies. Everyone is willing "to do a bit," and only the other day a chimney-sweep after having finished his work at one of these lodging-houses turned to the landlady and said: "Got any Belgians here?" and when she said "Yes," replied: "Then I makes no charge."

Of course a large number of the professors and students are literally destitute, but the University has collected a certain sum which enables our honoured guests to be clothed and fed, and even to provide the students with pocket-money every Saturday morning.

One rule was adopted from the very beginning and has been rigidly adhered to, and that is, *that only such students would be helped at Cambridge who had papers showing that they were physically unfit for military service, or had been rejected for other reasons by the Belgian authorities.* All students, therefore, who wish to avail themselves of the hospitality offered by the University of Cambridge and of the courses arranged by the

Belgian professors are requested to present themselves for medical examination before the proper authorities, and to obtain, in the event of their being rejected, a certificate to that effect. These arrangements have been made after direct consultation with the Belgian Government, which was good enough to send to Cambridge some few weeks ago, from Havre, an ex-Minister of Justice, who clearly explained the view of the Belgian authorities, and these views have been loyally adopted and followed in Cambridge.

Any student who wishes to avail himself of the opportunities offered by Cambridge should communicate with Mr. J. T. Sheppard, King's College, hon. sec. of the General Committee, or Mr. E. Bullough, Gonville and Caius College, hon. sec. of the Academic Committee. Genuine students at Belgian universities, who are members of the Allied Forces, *i.e.* French, Russian, Japanese, Servians, Montenegrins, are welcomed on the same terms as the Belgians. All are expected to observe the not very rigorous rules of the university which for a time is their host. Students at Belgian universities belonging to neutral countries, Sweden, Spain, Mexico, etc., are welcomed, but they must pay their way.

Classes in English for Belgian students have for some weeks been in progress, and they are graded carefully according to the needs of our guests. Those who have an adequate acquaintance with our language are following the ordinary university courses.

As an example of what is going on we append the list of lectures for the engineering course, and that for the students in commercial science. It seems to be a custom of the Belgian universities to have one complete week-day holiday in the week, and this day is not the same day in the varying faculties. It may be of interest to those who read Nature abroad to add a list of the resident Belgian professors in Cambridge, but this is necessarily incomplete.

Dr. Arien (Louvain), Prof. Bomerson, Prof. Breithof (Louvain), Prof. Carnoy (Louvain), Prof. Colson (Liège), Prof. Corbiau, Prof. De Groote, Prof. Déjace (Liège), Dr. Devigne (Liège), Prof. Léon Dupriez (Louvain), Prof. Van Gehuchten (Louvain), Prof. Gillet, Prof. Van Hecke (Louvain), Prof. Canon Van Hoonacker (Louvain), Prof. de La Vallée-Poussin (Ghent), Prof. Magnel, Prof. Nisot, Prof. N. Sibenaler, Prof. Steels, Prof. Van den Ven (professor of Byzantine Greek), Prof. Vanderstappen.

Cours Organisés à Cambridge pour les Etudiants des Ecoles d'Ingénieurs et de la Faculté des Sciences.

A. *Ecoles d'Ingénieurs.*

(Local : Engineering Laboratory, Free School Lane.

Lundi.—10h. à 11h. Calcul infinitésimal (Mr. V. Nisot). 11½h. à 13h. Résistance des Matériaux (traction, compression, cisaillement, flexion et torsion) (Mr. A. Van Hecke). 16h. à 18h. Géométrie descriptive, Géométrie descriptive appliquée, Graphostatique et travaux graphiques (Mr. F. Breithof). 16h. à 19h. Projets de résistance des Matériaux et de Stabilité des Constructions (Mr. Magnel).

Mardi.—16h. à 18h. Géométrie descriptive, Géométrie descriptive appliquée, Graphostatique et travaux graphiques (Mr. F. Breithof). 17½h. à 19h. Théorie du travail de déformation des solides élastiques (Mr. Magnel).

Mercredi.—11h. à 13h. Essai des Matériaux (Mr. A. Van Hecke). 16h. à 19h. Projets de résistance des Matériaux et de Stabilité des Constructions (Mr. Magnel).

Jeudi.—11h. à 12h. Calcul infinitésimal (Mr. V. Nisot). 16h. à 18h. Projets de résistance des Matériaux et de Stabilité des Constructions (Mr. Magnel).

Vendredi.—11h. à 13h. Essai des Matériaux (Mr. A. Van Hecke). 16h. à 18h. Projets de résistance des Matériaux et de Stabilité des Constructions (Mr. Magnel).

Samedi.—11h. à 13h. Stabilité des Constructions (Ponts et Charpentes (Mr. A. Van Hecke). 17½h. à 19h. Théorie du travail de déformation des solides élastiques (Mr. Magnel).

Mécanique appliquée (Mr. N. Sibenaler) aux jours et heures à déterminer. Matériaux de Construction (chaux et ciments) (Mr. A. Van Hecke), aux jours et heures à déterminer.

B. *Faculté des Sciences.*

(Local : Laboratoire de Chimie, Pembroke Street.)

Mardi.—11h. à 12h. Chimie organique (Mr. E. Colson).

Samedi.—11h. à 12h. Chimie organique (Mr. E. Colson).

Ces cours ne sont pas destinés à remplacer l'enseignement donné par les Ecoles d'Ingénieurs et par la Faculté de Sciences en Belgique, ni à préparer directement aux examens légaux. Ils ont pour seul but de maintenir les étudiants belges, réfugiés en Angleterre, dans les habitudes de travail et de contribuer à leur formation scientifique.

Cours Organisés pour les Etudiants Belges des Différentes Ecoles Supérieures de Commerce.

Première Année.

Lundi.—9h.–10h. Economie politique (Mr. Déjace). 10h.–11h. Sciences Commerciales : Comptabilité (Mr. Vanderstappen).

Mardi.—9h.–10h. Droit Civil (Mr. Bomerson). 10h.–11h. Sciences Commerciales : Arithmétique (Mr. Vanderstappen).

Mercredi.—9h. – 10h. Sciences Commerciales : Comptabilité. 10h.–11h. Sciences Commerciales : Arithmétique (Mr. Vanderstappen).

Vendredi.—9h.–10h. Droit Civil (Mr. Bomerson, à l'Ecole de Droit). 10h.–11h. Sciences Commerciales : Comptabilité (Mr. Vanderstappen).

Samedi.—9h.–10h. Sciences Commerciales : Algèbre financière (Mr. Vanderstappen). 10h.–11h. Economie politique (Mr. Déjace).

Seconde Année.

Lundi.—9h.–10h. Economie Politique (Mr. Déjace). 10h.–11h. Sciences Commerciales : Fonds publics (Mr. De Groote).

Mardi.—9h.–10h. Sciences Commerciales : Comptabilité des Sociétés Commerciales (Mr. De Groote). 10h.–11h. Droit Commercial (Mr. Bomerson).

Mercredi.—9h. – 10h. Sciences Commerciales : Algèbre financière (suite de 1^{re} année). 10h.–11h. Sciences Commerciales : Comptabilité des Sociétés Commerciales (Mr. De Groote).

Vendredi.—9h. – 10h. Sciences Commerciales : Algèbre financière (suite de 1^{re} année) (Mr. De Groote). 10h.–11h. Droit Commercial (Mr. Bomerson).

Samedi.—9h. – 10h. Sciences Commerciales : Comptabilités spéciales (Mr. De Groote). 10h.–11h. Economie politique (Mr. Déjace).

Les cours de Sciences Commerciales se donnent à l'Ecole de Droit, Downing Street.

PROF. AUGUST WEISMANN.

THERE is a strange and peculiar pathos in the death of this great man, formerly the friend, we may hope to the last the friend, of so many English naturalists, and in the thought that the gulf which had opened between us can never be bridged. For Weismann was among those who publicly renounced the marks of distinction which had been conferred upon them in this country.

In the limited space which is available, it is only possible to touch upon the main subjects of Weismann's scientific career. His earliest researches were physiological and histological, the first publication, on hippuric acid (1858), being followed by a series of six papers on the nervous and contractile tissues (1859–1862). Abandoning this subject, except for a single paper on muscle published in 1865, he threw himself with the utmost energy into his classical work upon the embryonic and post-embryonic development and metamorphosis of insects, producing five memoirs between 1862 and 1864, and a sixth in 1866. In the great monograph on the post-embryonic development of the Muscidæ (1864) the building up of the perfect form in the pupa is studied in detail, and it is shown that, in insects with a complete metamorphosis, the tissues undergo a breaking down or histolysis into an apparently simple and primitive mass, from which the imago is built up afresh by, as it were, a second embryonic development. Thus the long series of slightly modified progressive steps by which, in the more ancestral groups, the earliest stage is transformed into the latest, has been shortened, in the more recent forms, into a single intermediate stage in which everything is broken down and built up again from the beginning, establishing the truth of Aristotle's statement that "the chrysalis has the potentiality of the egg."

Insect development was followed by a great series of memoirs (1874–1880) on the minute Crustacea—Daphnids and Ostracods—and these again by the epoch-making researches into the sexual cells of the Hydrozoa, published in four papers between 1880 and 1882, and, in 1883, in the great quarto monograph, "Die Entstehung der Sexualzellen bei den Hydromedusen." With the appearance of this work Weismann's eyesight became too weak for prolonged microscopic research, and he turned to other and more general problems of thought and inquiry.

Weismann was attracted early in his career towards the problems of the history and causes of evolution. "The Origin of Species" appeared in the year following the publication of his first paper, and in 1868 he brought out "Ueber die Berechtigung der Darwin'schen Theorie," followed in 1873 by his paper on the influence of isolation, written in answer to Wagner. The "Studien zur Descendenz-Theorie" (1875) included a variety of subjects treated from the evolutionary point of view—the seasonal dimorphism of butterflies, the markings of caterpillars, phyletic parallelism, the transformation of the Mexican axolotl, and the mechanical conception of nature. This important and stimulating work, translated into English with many additional notes by Raphael Meldola, and with a preface by Charles Darwin, was published in 1882. The present writer well remembers the interest with which he looked forward to the parts as they successively appeared, and the instant resolution to continue some of the lines of work.

The central thought which branched forth so luxuriantly during the last thirty years of Weismann's life sprang from his researches on the sexual cells of the Hydrozoa. By these he was led to conclude that, however ordinary their appearance, the germ-cells contain something essential for the species, something which must be carefully preserved and passed on from one generation to another. It was this conclusion, so Weismann told the present writer in 1887, which led directly to the hypothesis of "The Continuity of the Germ-plasm," with all its far-reaching consequences. In Darwin's pangenesis the germ-cells are derived from the body-cells, whereas in Weismann's contrasted hypothesis the body is an outgrowth from the germ. From this conception Weismann was led to contrast the mortal soma with the potentially immortal germ, and to question the hereditary transmission of acquired characters. Excluded from the Darwinian interpretation of germinal variation as a consequence of gemmules dispatched to the germ by environmentally modified body-cells, Weismann looked for the origin of variation in the kaleidoscopic combination of innumerable ancestral factors brought about by sexual reproduction. He thus sought to explain the meaning of sexual reproduction itself as well as the events which lead up to the fusion of the male and female germ-cells.

The subjects thus briefly enumerated, treated in eight memoirs published between 1881 and 1888, were translated and appeared in a collected form in this country as "Essays upon Heredity and Kindred Biological Problems" (1889). The translation of four additional memoirs (1886–1891) was published as a second volume in 1892, the year in which he produced "The Germplasm," translated by Prof. W. Newton Parker, and published in this country in 1893. An elaborate and remarkable hypothesis, "Germinal Selection" (1896) was followed by the comprehensive treatise on the evolution theory, which brought his long and fruitful life-work to a close. The two volumes passed through three editions between 1902 and 1913, the English translation by Prof. and Mrs. J. Arthur Thomson appearing in 1904, the year of the Festschrift, which celebrated Weismann's seventieth birthday.

Weismann was a naturalist keenly interested in living nature, as may be inferred from "Das Thierleben im Bodensee" (1877), the fruit of many a holiday spent in the study of aquatic life. He was a delightful and sympathetic companion, possessed of a noble simplicity. To younger men he was generous and sympathetic, and many will remember the encouragement they received from his kindly appreciation. Apart from scientific work Weismann found his chief recreation in music, and with Huxley he could quote Landor's line—

> I warmed both hands before the fire of life.

Throughout a long and energetic life Weismann worked with enthusiasm and success at the subjects nearest to his heart. Many have done the same, but there are few whose chosen labours have done so much to stimulate the work and the thought of others.

E. B. P.

NOTES.

THE collections made by the well-known naturalist and sportsman, Mr. C. V. A. Peel, during the travels and hunting expeditions of twenty-four years, have for long formed a centre of attraction in the city of Oxford. They are housed in a specially-built museum in the Woodstock Road, and include many objects of considerable scientific interest. Among the mammals preserved in the collection are well-mounted examples of the African and Indian elephants, a fine head of the so-called "white" rhinoceros, and a good specimen of the Somaliland eland. Many other species of African antelopes are well represented. The collections are also rich in birds, reptiles, and fishes, the latter including some fine and well-preserved examples of the Salmonidæ. The insects and arachnida, several of which were new to science, collected by Mr. Peel in the "horn" of Africa during the years 1895 and 1897, formed the subject of a paper in the Zoological Society's Proceedings for 1900. His adventurous journeys in that region were fully described by him in his book, "Somaliland," published in 1899. The more important invertebrate captures have been lodged in the Hope Collection at Oxford, and in the British Museum (Natural History), but the remainder, together with the extensive series of vertebrates above referred to, and the building in which they are displayed, have now been generously presented by Mr. Peel to the city of Oxford.

IN reply to a question as to British manufacture of synthetic dyes asked in the House of Commons on Monday, November 23, Mr. Runciman said:—"Since the beginning of the war the earnest attention of his Majesty's Government has been given to the best means of averting the grave danger of stoppage of employment in the textile and other industries which depend upon a supply of colours owing to the interruption of imports from Germany. Emergency measures are already being taken to secure for the time being the continuity of supply of dyestuffs by encouraging the immediate development of existing sources in the United Kingdom and elsewhere. In addition, however, the inquiries of the Government have led them to the conclusion that the excessive dependence of this country on a single foreign country for materials of such vital importance to industries in which millions of our workpeople are employed constitutes a permanent danger which can only be remedied by a combined national effort on a scale which requires and justifies an exceptional measure of State encouragement. Accordingly the Board of Trade has entered into consultations with the principal interests concerned with a view to the elaboration of a scheme for the establishment of an undertaking for the production of synthetic dyes and colours. In the main it is hoped that the capital required will be forthcoming from the industries by which dyes and colours are mainly used, but the Treasury is prepared within certain limits, and subject to certain conditions, to afford financial support to a well-considered scheme which will be permanently under British control. I am not prepared at the moment to enter into fuller details, because several matters are still the subject of confidential negotiations, but further information will be made public as soon as practicable."

THE death is announced, at sixty-six years of age, of Dr. G. F. W. Thibaut, registrar of the University of Calcutta since 1906, and formerly assistant to Prof. Max Müller, in the preparation of the later volumes of the great edition of the "Rig Veda," as well as the smaller text edition, and principal of the Muir Central College, Allahabad.

WE regret to see the announcement of the death on November 20 of Dr. J. Burney Yeo, Emeritus Professor of Medicine, King's College, London, and author of "A Manual of Medical Treatment," "Food in Health and Disease," "The Therapeutics of Mineral Springs and Climates," and numerous articles and papers published in medical and other journals.

THE death is announced from Bulawayo of Mr. R. N. Hall, author of "Prehistoric Rhodesia" and a number of papers on South African races and traditions. Mr. Hall arrived at the conclusion that the old mines and ruined temples of Rhodesia, including the Zimbabwe temple, date from ancient times, and were due to Semitic immigrants—a view opposed to that reached by Dr. R. Maciver in "Mediæval Rhodesia," in which it is held that the buildings at Zimbabwe are the work of a native race of comparatively modern times.

THE most important contribution to the August issue of the *National Geographic Magazine* is an account by Messrs. Ellsworth and Emery Kolb of their experiences in the Grand Cañon of Arizona. The writers have lived for twelve years at the head of the Bright Angel trail, and from this point have made repeated excursions into this stupendous gorge. The first part of the article describes a trip to what is considered the most beautiful of the tributary cañons, that of Cataract Creek; the second an exploration of the cañon of the Little Colorado; the third a repetition of Major Powell's famous journey down the Green and Colorado rivers. The article is illustrated by a splendid collection of photographs procured at imminent risk to life and limb. The monograph fully describes the geography, scenery, and geological features of this remarkable gorge.

IN the issues of the *National Geographic Magazine* for September and October, the immense stock of photographs at the disposal of the National Geographic Society of Washington has been drawn on to supply a more vivid and instructive record of the countries engaged in the present war than has hitherto appeared in any British publication. France, Belgium, Germany, Hungary, and England are each in its turn illustrated by admirable views of scenery, architecture, and country life. Prof. R. G. Usher, professor of history in the University of Washington, dealing with England, "the oldest nation of Europe," gives a survey of its historical progress and industrial resources in relation to the present war. He sums up the situation by remarking: "While no one who is truly candid will deny that England has still much to attain in political and social consciousness and a long road to travel before the national consciousness will become instinctive upon aught but the simplest subjects, he will still be compelled to admit that England has progressed further in spiritual national consciousness than any other community in the world simply because the early attainment of territorial and racial unity enabled the ancestors of the present Englishmen to begin living together long, long before the final elements of other nations had been assembled."

AN interesting phase in the evolution of art is discussed by Mr. F. G. Speck in his monograph on the double-curve motive in north-eastern Algonkian art, published as Memoir 42 by the Department of Mines, Canada. After fully describing, with abundant illustrations, the development of this form of decoration, he arrives at the conclusion that we find in it an originally non-symbolic decorative element, presumably an indefinite plant or floral figure, common to all members of the north-eastern Algonkian group both north and south of the St. Lawrence. Passing from this primary area, the motive has been borrowed by other western tribes, mostly Algonkian, and subjected to local modification. Among the Penobscots and perhaps their eastern neighbours the double curve has acquired, to a certain degree, a symbolic value due to contact with the more politically complex Iroquois. These positions, he admits, may require modification when the study of symbolism among the tribes east of the Penobscots, and the inter-relation between their art as a whole and that of the Iroquois, come to be more carefully investigated.

THE twenty-second report of the Board of Health on leprosy in New South Wales for the year 1912 has been issued. On January 1 of that year only eighteen persons remained under detention at the lazaret. During the year five persons were reported to the Board as being suspected lepers, of whom four were certified as suffering from leprosy. Details are given of the condition of these new patients and of the methods and results of the treatment of the old cases.

THE National Council for Combating Venereal Diseases was inaugurated at the Royal Society of Medicine on November 11. The gathering was a distinguished one, and representative of widely different interests. The aims and objects of the council are the following:—(1) To provide accurate and enlightened information as to the prevalence of these diseases, and as to the necessity for early treatment. (2) To promote the provision of greater facilities for their treatment. (3) To increase the opportunities of medical students and practitioners for the study of these diseases. (4) To encourage and assist the dissemination of a sound knowledge of the physiological laws of life in order to raise the standard both of health and conduct. (5) To co-operate with existing associations, to seek their approval and support, and to give advice when desired. (6) To arrange, in connection with such organisations, for courses of lectures, and to supervise the preparation of suitable literature. (7) To promote such legislative, social, and administrative reforms as are relevant to the foregoing aims and objects.

IN the course of a paper on the birds of Costa Rica, published in the September number of *Zoologica,* Mr. L. S. Crandall remarks that the alleged scarcity and shyness of the brilliantly coloured king-vulture are not borne out by his experience, several of these birds allowing themselves to be approached within a distance of forty yards while feasting on a carcase. In a second article Mr. C. W. Beebe discusses the Himalayan and Far Eastern kalij-pheasants of the genus Gennœus, and concludes that the number of species has been much exaggerated.

AT the conclusion of an article on the responses or reactions of animals and plants to stimuli—as exemplified by changes in function, structure, and colour induced, either directly or indirectly, by external conditions—published in the *American Naturalist* for November, Prof. V. E. Shelford remarks that, in his opinion, the doctrines of purposeful advantageous response, of natural selection, and of the continuity of the germ-plasm cannot be accepted in their entirety. "Each appears to have arisen from a recognition of certain more or less unconsciously selected and uncritically determined phenomena by each of several men who secured different facts and attempted explanations."

IN the November number of *Wild Life,* Mr. Russell Roberts, who, we believe, is now serving with the army, resumes the account of his personal experiences of African big game, dealing in this instance with the black rhinoceros, of which several striking photographs are given. The author totally discredits the alleged excessive ferocity of this species, remarking that reports to this effect are for the most part due to want of sufficient acquaintance with the animal. A wonderful photograph of a sedge-bird, by Mr. Lodge, and a second of waterfowl on the lake in Woburn Park are other features of this issue. An article on the Zoological Gardens is marred by the statement that certain Australasian marsupials range as far *east* as New Guinea.

SAN FRANCISCO has started a new journal, to be published quarterly by the California Fish and Game Commission, under the title of *California Fish and Game,* the first number of which appeared in October. California, it seems, has not yet fallen into line with the neighbouring States in the matter of the prohibition of the sale of wild ducks and other wild table-birds; and it has been made a ground of complaint that wild ducks reared in Oregon and Washington migrate into California, where they are ruthlessly shot and sold. A Bill was introduced into the local legislature last year with the object of remedying this state of affairs, but was defeated as the result of a *plébiscite*. The greater portion of the contents of the first number of the new issue is devoted to arguments in favour of amending the present anomalous condition of affairs.

WE have much pleasure in congratulating the Royal Zoological and Acclimatisation Society of Victoria on the attainment of its "jubilee." In the fiftieth report of the council, for 1913, it is stated that the first buildings in the then newly-formed gardens at Melbourne were erected in June, 1862. The early efforts of the society were entirely restricted to acclimatisation, and it was not until 1870 that "Zoological" was added to its title, and that foreign animals were imported solely for the purpose of public exhibition. Judging from the photographs in the jubilee report, the collection of such imported animals must now be a fine one, but to an English eye the greatest attraction of the Melbourne Gardens must be the native Australasian species, among which we may specially refer to a group of tree-kangaroos or tree-wallabies, photographed amid the branches of a tree, in the report.

ACCORDING to the report of the general meeting held on November 17, the Zoological Society is suffering severely from the collateral effects of the war, the number of visitors to the gardens during August, September, and October being 307,826, or 124,154 fewer than during the corresponding period of 1913. The total number of visitors during the year has so far been 1,011,526, and the take of gate-money 23,786*l.*, or a decrease in the number of visitors of 75,059 and in the receipts of 2879*l.*, as compared with the first ten months of last year. Nevertheless, the fact that on October 25 the number of visitors who had passed the turnstiles during the year reached a million is a record which has been equalled only twice during the last eighty-six years. Eighteen new fellows were elected, and twenty-one candidates for the fellowship or honorary membership and eight for the corresponding-membership were proposed. The number of fellows hitherto elected during the year is 263, or three fewer than in the corresponding portion of 1913, this being, however, an increase of forty-seven above the average at the corresponding date for the last ten years. During August, September, and October 620 additions had been made to the menagerie—444 by presentation, 51 by purchase, 58 on deposit, 29 by exchange, and 38 born in the gardens.

IN the *Ophthalmic Review* for September, Dr. Edridge-Green publishes a short account of his theory of vision, and adduces the facts and arguments which have led him to its adoption. According to this theory the cones are the only terminal perceptive visual organs, the function of the rods being confined to the formation and distribution of visual purple. Vision he supposes to take place by stimulation of the cones through the photo-chemical decomposition of the liquid in which they are bathed, this liquid being sensitised by the visual purple. As against the argument that the visual purple is absent from the macula lutea, the region of most distinct vision, he adduces two observations by Devereux Marshall and himself on the eyes of monkeys which had been kept in the dark for forty-eight hours before being killed. He states that in these circumstances the yellow spot was the reddest part of the whole retina owing to the diffusion of visual purple from the surrounding parts of the retina between the cones. It is a pity that these observations have not yet been confirmed. Assuming their correctness, Dr. Edridge-Green brings forward many other considerations which tell in favour of his view. An important point in his argument is the absence of qualitative difference between central and peripheral vision, and he is supported by Tschermak, Hering, Hess, and Garten in his assertion that the difference between the vision of foveal and parafoveal areas is merely quantitative. The difference between the sensibility of the light and dark adapted eye he shows to be analogous to the difference in the spectral distribution of chemical effect with varying intensities of illumination. Several subjective visual phenomena are shown by him to agree with the theory.

A USEFUL paper by Mr. B. C. Wallis entitled, "The Distribution of Rainfall in the North-eastern United States: its Causes and Results," is published in the *Scottish Geographical Magazine* for November, based upon observations contained in the annual report of the United States Weather Bureau. The area embraces districts in which corn, cotton, and tobacco are cultivated, and various maps and diagrams show by means of "equipluves," or lines of equal average rainfall coefficients or percentages, the areas and dates of the wettest and driest months, and consequently the districts where such industries can best be carried on. The diagrams show, among other things, (1) that the maximum rainfall occurs between 130 and 140 per cent. of the normal, and that the minimum occurs between 70 and 80 per cent. of the normal, and (2) that in the north the rise in the rate of precipitation is faster than the fall, while in the Ohio valley and to the south-east the opposite is the case. The method is admittedly not new; it is fully explained in the Quart. Journ. Roy. Met. Soc. for October last (p. 311), and in an instructive note (p. 322) Mr. C. Salter states that a very similar method (the results of which were embodied in a paper to the society on November 18) has been for some years adopted by the British Rainfall Organisation. The usual *monthly* rainfall averages are expressed as percentages of the *annual* value at each station; in this way some "exceedingly interesting facts" are disclosed, with many fewer stations than are necessary when dealing with maps of actual monthly averages.

AN abstract of the results obtained by Mr. H. L. Curtis, of the Bureau of Standards, during his tests of the resistivities of nearly seventy insulating materials, appears in the Journal of the Washington Academy of Sciences for October 19. In all cases contact with the material was made by means of mercury electrodes, and the effects of surface leakage were eliminated by the use of a guard ring. The temperature of the specimen and the humidity of the surrounding air do not affect the order of magnitude of the results, but for the best insulators the time of application of the voltage has a serious influence on the values obtained. Some of the most useful results are:—Fused quartz, special paraffin, and ceresin, all over 10^{18}; micas from 10^{17} to 10^{13}; sulphur, 10^{17}; bakelite, 10^{16} to 10^{11}; glass, 10^{16} to 10^{12}; unglazed porcelain, 10^{14}; paraffined wood, 10^{13} to 10^{11}; marble, 10^{11} to 10^{9}; and slate, 10^{8} ohms per centimetre cube. One of the most noticeable features of the table given by the author is the great difference between the insulating properties of different specimens of materials going by the same name.

A VERY interesting example of an experimental steam engine and accessories has just been supplied to the Marine School, South Shields, by Messrs. W. Sisson and Co., Ltd., of Gloucester. An illustrated description of this engine appears in *Engineering* for November 20. The engine is of the quadruple expansion type, and has four cylinders operating on four cranks, set at such angles as to give the best balancing results. The arrangements permit of the engine being run as a triple-expansion or compound engine, as may be found expedient for experimental purposes. The high-pressure cylinder is jacketed, and is provided with Meyer's expansion gear, operating on piston valves. The first intermediate cylinder is also steam-jacketed, and has a piston valve of the maker's special labyrinth type. The second intermediate and low-pressure cylinders have single-ported, flat-faced slide valves. Each cylinder has Stephenson's link-motion reversing gear. The engine drives either a dynamo or a Heenan and Froude dynamometer. The air-pump is of the ordinary single-acting type, and the surface condenser is independent of the engine.

A GREAT deal of experience has now been acquired regarding the cost of operating and maintaining systems of substations required in electric railway installations, and Dr. H. F. Parshall read a paper at the Institution of Civil Engineers on November 17 having for its object the assisting towards the standardisation of electric railway substation practice. The number of independent variables when a complete system with substations has to be dealt with is so great that the mathematical expression, from which might be deduced the minimum cost, would in practice be open to some suspicion. Hence the author gives in the paper a complete balance-sheet embodying every item for each case; without any great amount of labour, the methods and results given may be applied to practically any class of electric railway installation. Curves are also given showing the arrangements of substations that will operate different train services on different electrical systems, and at various voltages with a minimum total operating cost. Curves are included illustrating the advantages gained by working at high voltages, and these confirm Dr. Parshall's view that with the present arrangement of rotary-converter substations, there is little advantage in a higher voltage than 2400 for the track conductor.

ERRATUM.—On p. 318, col. 2, line 9 from bottom, for "miles" read "metres."

OUR ASTRONOMICAL COLUMN.

COMET NEWS.—Comet Delavan (1913*f*) is a morning object but situated low down. The following two-day ephemeris has been communicated by the Observatory of Copenhagen, and is a continuation of that which appeared in the *Astr. Nachr.*, No. 4756:—

Ephemeris 12h. Mean Time Berlin.

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
Nov. 25	15 37 56	+6 9·3	
27	42 16	5 2·0	5·2
29	46 31	3 56·5	
Dec. 1	50 39	2 52·6	5·2
3	15 54 41	+1 50·2	

Last week the elements and ephemeris of Lunt's comet (1914*d*) were given in this column. It seems that this comet was discovered independently by several observers, and the Lick Observatory Bulletin No. 262 gives the elements and ephemeris of Comet 1914*e* (Campbell), which refers evidently to the same object. In this bulletin it is stated that the first telegraphic announcement from the Harvard College Observatory described it as a bright comet seen in the southern constellation Doradus by Leon Campbell at Arequipa. As the ephemeris given in this column last week differs slightly from that printed in this bulletin, a portion of it is reproduced below:—

Greenwich Mean Midnight.

	R.A. (true) h. m. s.	Dec. (true) ° m. s.
Nov. 25·5	21 54 45·0	+9 58 43
27·5	56 1·3	10 19 52
29·5	57 20·8	10 40 28
Dec. 1·5	58 42·9	11 0 35
3·5	22 0 7·7	+11 20 17

In *Knowledge* for November, Dr. Crommelin gives an interesting account of former appearances of Encke's comet, together with a chart illustrating the approach of this object to Mercury about twelve days after its perihelion passage, which occurs on December 5 next. The comet, he states, is likely to be a conspicuous object in November. The following is a portion of the ephemeris which he publishes:—

Ephemeris for Berlin Noon.

	R.A. h. m. s.	Dec. ° ′
Nov. 26	14 41 46	−10 16
30	14 57 33	14 20
Dec. 4	15 17 20	18 3
8	15 41 12	21 18
12	16 7 27	23 54
Dec. 16	16 34 6	−25 50

Mr. Denning, in the *Observatory* for November, communicates a short article on Encke's comet, and gives a table of all the comet's returns, with the dates of its redetection and periods.

SPARK SPECTRUM OF NICKEL UNDER PRESSURE.—Attention has often been directed in this column to many investigations regarding the fact that the wavelengths of spectrum lines, determined from measurements in the solar absorption spectrum, display small differences when they are compared with the measurements of the same lines in spectra secured from terrestrial light sources. Numerous observers have attributed these discrepancies to the effect of pressure, but more recently Mr. Evershed has ascribed the solar displacements to Doppler effects. It is of importance, therefore, to pursue the study of the effect of pressure on the behaviour of lines in spectra, and in this connection the investigation of the spark spectrum of nickel which has been completed by Mr. E. G. Bilham

(*Phil. Trans.*, Roy. Soc., Series A, vol. ccxiv., pp. 359–71) will be found a useful piece of research. In the present investigation the effect of pressures up to ten atmospheres above the normal atmospheric pressure has been studied, the work having been carried out at the Imperial College of Science and Technology at South Kensington. Details regarding the method employed, the spectroscope, measuring apparatus, etc., are stated briefly, followed by descriptions of the character of the lines studied, results of measures, classification of shifts, and the behaviour of some special lines.

Summarising the results, it may be stated that the lines exhibit a variety of behaviour, and have been divided into five classes depending on the types of reversal and broadening. The enhanced lines were observed to decrease in intensity and broaden symmetrically with increase of pressure. The general effect of pressure on the relative intensities of the lines is similar to that of including self-induction in the spark circuit; pressure also causes gas lines to disappear. The displacement of all lines is towards the red. The average shifts are the same for symmetrical as for unsymmetrical reversals, but the shifts are larger for unreversed than for reversed lines, and are greatest for lines broadening unsymmetrically towards the red. Mr. Bilham finally directs attention to two lines (3514·14 and 3608·98 approx.) the abnormal behaviour of which under pressure suggest that they are enhanced lines. Two excellent plates accompany the paper, reproducing three portions of the spectrum of nickel under the pressure of one, six, and eleven atmospheres, and the abnormal behaviour of the last two lines mentioned above.

The Berkeley Astronomical Department.—The results of the researches carried out in the Berkeley Astronomical Department, under the auspices of the University of California, are printed in the established Lick Observatory publications. Vol. vii. of the Publications of the Lick Observatory, recently issued, is devoted completely to a number of researches carried out under the director, Prof. A. O. Leuschner, at the above-mentioned institution. The volume consists of ten sections, some of which have already been issued in separate parts, but others have been delayed in printing owing to lack of funds. The papers are chiefly devoted to methods of determining orbits, the short methods of computation by Prof. A. O. Leuschner being the more extensive. Among the other contributions are the elements of Asteroid 1900 GA by A. O. Leuschner and Adelaide M. Hobe, preliminary elements of comet 1900 III. by R. H. Curtiss and C. G. Dall, tables for the reduction of photographic measures and investigation of the Repsold measuring apparatus by Burt L. Newkirk, and a research on astronomical refraction by Russell T. Crawford.

GEOLOGICAL WORK IN INDIA AND ITS BORDERLANDS.

THE series of publications maintained by the Geological Survey of India allow scope for memoirs on all branches of geology. We may select for mention the following typical papers from recent issues of the Records.

In vol. xli. (1912), p. 266, T. D. La Touche describes the Lonar Lake in Berar, in the Central Provinces, and ascribes its steep-sided basin to the sinking back of a mass of lava which once uplifted the surface as a shallow dome. The rocks round the depression are amygdaloidal lavas; but no sign of crater-formation can be traced. W. Christie (p. 276) reports on the sodium carbonates that give a commercial interest to the lake. He points out that potassium, as usually happens, is retained by the insoluble products of the decomposition of the lavas, so that sodium is the main alkali supplied.

The geological results of the Abor military expedition are stated by J. Coggin Brown (vol. xlii., p. 231), whose notes, although taken during rapid movements in a mountainous country, provide a fairly continuous section up the Dihong river. Limestone boulders with crinoids have been found (p. 240), indicating the northern edge of the Gondwana continent. Both in Canada and Burma we have learnt how such traverses along natural highways may help, when correlated, to explain the structure of wide areas.

The director, H. H. Hayden, discusses (vol. xliii., p. 138) the relationship of the Himalaya to the Indo-Gangetic plain, and emphasises, in the consideration of geodetic results, the low density of the alluvium of the plain and of the Siwalik beds that probably underlie it. He concludes that there is no need to suppose the existence of a huge trough filled with alluvium at the foot of the Himalayan range. While Hayford calculated that the layer of isostatic compensation, where the rocks are subject to equal pressure from all directions, lies in North America at a depth of 122 km., Hayden (pp. 145 and 154) suggests that it may occur in India at a very much greater depth. Where slow earth-movements are still in progress, compensation may not be attained in the layers near the surface of the earth. He concludes (p. 167) that "the geodetic evidence seems to confirm the generally accepted view that the Indo-Gangetic depression is a broad basin, shallow on the outer side and sloping gently inwards towards the Himalaya" at a little more than 2°. The range is separated from it "by a steep wall resulting from the series of reversed faults which separate the older geological systems from the younger." This matter has been discussed by Sir T. H. Holland in his address to the geological section of the British Association in 1914.

J. Coggin Brown publishes a series of contributions to the geology of the province of Yünnan, in Western China, and R. C. Burton describes the volcanic rocks (vols. xliii., pp. 173, 206, and 327, and xliv., 1914, p. 85). In these papers recent changes in the course of the Irrawaddy are mentioned, and the river is said to have been shifted by earth-movements in very recent times into higher country to the west of its former line of flow. The volcanoes of the Têng-yüeh area were active in recent or late Cainozoic times; their cones and craters are preserved, and hot springs still occur. Their disposition and the nature of their products indicate (p. 226) that they are a prolongation of the chain which runs through Java and Sumatra. F. R. Reed adds greatly to the third paper by determinations of the Ordovician and Silurian fossils (these results being termed "provisional" in the text and "provincial" on the cover of the records). An interesting Baltic relationship is pointed out (p. 334). A marked change of conditions occurred in Upper Permian times, when the marine limestones with Fusulina and Schwagerina, which mark the Permo-Carboniferous system, are replaced by terrestrial conglomerates and sandstones, with finally a small marine incursion, giving rise to lagoons and salt-beds (vol. xliv., p. 112).

G. E. Pilgrim contributes a paper of the widest interest on the correlation of the Siwaliks with mammal horizons of Europe (vol. xliii., p. 264). The table forming plate 26 shows the Tertiary river deposits of India, opening with the Gaj Beds as Lower Burdigalian or Upper Aquitanian. The Murree Beds are Burdigalian to Tortonian; the Lower Siwaliks extend from the Tortonian to the top of the Sarmatian of Europe, and the Middle Siwaliks from the base of the Pontian to what is here taken as Lower Pliocene—that is, Placentian. The Siwalik system ends as "Uppermost Pliocene." The Siwalik system is 14,000 to 16,000 ft. in thickness. Another philosophic paper is by G. De P. Cotter, on the value of Nummulites as zone fossils (vol. xliv., 1914, p. 52). This includes a discussion of Hein's view that nummulites depend a good deal on lithological facies. The author believes (p. 67) that the same uncertainty occurs in dealing with Orbitoides (including Orthophragmina and Lepidocyclina).

Aerolites receive much attention in these recent volumes. G. Cotter describes records in India since 1906 (vol. xlii., p. 265); J. C. Brown deals with the fragments that came from a meteor seen to explode at Banswal, near Dehra Dun, on January 18, 1913 (vol. xliii., p. 237); and W. A. K. Christie describes "A Carbonaceous Aerolite from Rajputana," which fell from a meteor at Chhabra, in Tonk, on January 22, 1911. The carbon of this chondritic mass amounts to 2·7 per cent., and the stone is surpassed in this respect by that of Alais alone. The composition of the carbonaceous matter is not graphitic, and is very uncertain.

Among the papers published separately as Memoirs of the Geological Survey of India we may note Prof. C. Diener's general description of "The Trias of the Himálayas." The author (p. 55) draws the boundary between Permian and Trias below the Otoceras beds in the Himalayas, and between the Bellerophon Limestone and the Lower Werfen beds in the Eastern Alps. In correlating the strata, his survey extends through the Malay Archipelago to the Pacific region. The Mediterranean facies of the Trias is shown (p. 149) not to extend into Afghanistan. "The northern borderland of the Indian Triassic province corresponds to the southern shore of the Angara continent (Suess)" (p. 152).

H. H. Hayden's "Geology of Northern Afghanistan" (vol. xxxix., part 1), contains fine illustrations of the crags and "bad lands" of a typically dry country, dissected by seasonal rains. The highest Carboniferous beds are of the Fusulina Limestone type, and the Cenomanian transgression affects the region. T. H. D. La Touche's memoir on the geology of the northern Shan States of Burma (vol. xxxix., part 2) should be studied in connection with J. Coggin Brown's work on Yünnan, cited above. P. N. Datta was associated with the author in the prolonged field investigations. The ruby mines of Burma occur in this region (pp. 34 and 371), and it is now suggested that the gem-bearing limestone is a band of sedimentary origin. The pisolitic ferruginous clays among the recent deposits (p. 322) are compared with the laterite of India; and the dams of calcareous tufa in the streams, originating in calcium carbonate carried down from limestone plateaus, are of interest for comparison with those of Bosnia and Dalmatia (p. 324). The glacial Talchir beds are traced into the little-known state of Korea in the Central Provinces by L. L. Fermor, in a memoir on the coal-resources of the district (vol. xli., part 2); and J. Coggin Brown reports on the Burma earthquakes of 1912 (vol. xlii., part 1).

The folio memoirs issued under the title of "Palæontologia Indica" are continued by G. E. Pilgrim's report (vol iv., Mem. 2) on the vertebrate fauna of the Gaj series, the stratigraphical results of which are utilised in the author's paper on the Siwalik beds, mentioned above. Prof. A. C. Seward, of Cambridge, describes "Lower Gondwana Plants from Kashmir" (vol. iv., Mem. 3) *Glossopteris indica* prevails, and the author throws doubt on the existence of *G. decipiens* as an independent species. He also deals with "Mesozoic Plants from Afghanistan and Afghan-Turkistan" (vol. iv., Mem. 4), which are beautifully illustrated by T. A. Brock. An interesting map on p. 46 shows, with the aid of a table (p. 45), the wide range of many Mesozoic species or of closely allied forms. *Coniopteris hymenophylloides,* for example, is found in Australia, Arctic Europe, Great Britain, and generally throughout Asia. The highly specialised molluscan fauna of the Spiti Shales is studied by Karl Holdhaus (series xv., vol. iv., part ii., fasc. 4), who concludes (p. 398) that these Jurassic strata probably belong to the upper part of the system.

In the Records of the Mysore Geological Department, vol. xi., issued in 1912, W. F. Smeeth (p. 49) refers the laterites of the State to two series, one modern, produced by the superficial decay of various types of rock, and one older, the "great Mysore sheet," originating in materials precipitated from the waters of lakes, and afterwards laid dry and subjected to laterising conditions. On p. 56 Smeeth urges that the so-called fundamental gneiss of Mysore is intrusive in the Kolar schists, and that "Mysore may be regarded as a house in which the superstructure has been underpinned and a new foundation substituted for the original one." The intrusive nature of the gneisses is further emphasised by P. S. Tyengar and B. Jayaram in vol. xii. of the Records, issued in 1914 (pp. 64 and 77).

J. B. Scrivenor has issued through the Government Printing Office at Kuala Lumpur a paper on the geology and mining industries of Ulu Pahang, in the Malay States, a region traditionally supposed to possess immense mineral wealth. After three years' investigation, the author found but little tin-ore, and he concludes that the old workings for gold were made by persons as economical in their habits as those who carry on the work in the very poor alluvial ground to-day (p. 12). He directs attention (p. 32) to the soils of the andesitic Pahang series as likely to furnish a compensation in agricultural prosperity. The petrographic sections, including radiolarian chert, and the landscape illustrations, reproduced in collotype by Bemrose of Derby, are of remarkable beauty. Another work by J. B. Scrivenor, on the geology and mining industry of the Kinta district, Perak (Kuala Lumpur, 1913; price 3 dollars), is equally well illustrated. The author points out (p. 20) how road-cutting and hydraulic mining have been facilitated by the tropical processes of weathering, whereby the ground-water carries away silica in solution, and "hard, unyielding masses are reduced to the consistency of putty." The most important conclusion in this memoir is that the clays and boulder-clays of Perak, which are mined for the detrital tin-ore which they contain, are not of recent origin. They have been penetrated by the local Mesozoic granite, and rest on the Carboniferous Kinta Limestone. Excellent reasons are given (pp. 38–43) for correlating them with the Permian glacial beds of India. It is remarkable that the tin-bearing and tourmalinised Mesozoic granite must have been preceded in this area (p. 35) by a similarly tin-bearing granite, which formed a contact-aureole, and from which the granite boulders and the cassiterite in the glacial clays have been derived.

G. A. J. C.

RAINFALL IN THE PHILIPPINES.

THE Manila Weather Bureau has published a very useful paper on the annual amount and distribution of rainfall over that archipelago, prepared under the direction of the Rev. J. Algué, S.J., by the assistant-director, the Rev. M. S. Masó, S.J. It includes tables showing, *inter alia,* the monthly and annual values for separate years and means for the whole period embraced, which, in most cases, refers to years since 1902. In an interesting discussion of the data in English and Spanish it is explained that owing to the N.–S. extension of the archipelago and to the main trend of the mountain ranges in the same direction there is much variety in the distribution of the rainfall which is quite opposite in some instances in the eastern and western regions. The latter experience a dry winter and spring and a wet summer and autumn, while in the eastern regions rain is prevalent in autumn and winter. February–April are generally the driest months over the whole archipelago, but as soon as the sun reaches the northern hemisphere thunderstorms and heavy showers become more frequent.

The average yearly rainfall over the whole area is 2400 mm., the extreme values being 900 mm. at Zamboanga (south-west Mindanao), and 4500 mm. at Baguio (west-central Luzon). With some exceptions the average for the northern, eastern, and western coasts exceeds 2000 mm.; it seldom reaches that amount in the valleys, but attains to 2000–3000 mm. in the highlands, and even reaches 4000 mm. in the Baguio plateau at an altitude of 1400 metres. In parts of the east and south-east coasts of Luzon, eastern Samar, and north-east Mindanao, the average is above 3000 mm. There are no large, specially dry regions; whenever a relative failure of rainfall occurs it is generally felt throughout the whole archipelago.

NORTH AMERICAN FROGS AND TOADS.

THE life-histories of North American frogs and toads form the subject of a memoir entitled "North American Anura — Life-histories of the Anura of Ithaca, New York," by Mr. A. H. Wright, just received from the Carnegie Institution of Washington. In the introduction to this highly interesting and well-illustrated work the author acknowledges his indebtedness to Boulenger's "Tailless Batrachians of Europe," published by the Ray Society in 1897–98, which has given the original impetus to and has been taken as the model for his study. The region investigated is at the southern end of Cayaga Lake, and most of the observations were made in the vicinity of Ithaca, New York. The number of Anurous Batrachians included within these limits is small, and only three genera, the widely distributed Bufo, Hyla, and Rana, are represented. The species are the common toad, *Bufo lentiginosus americanus*, the peeper, *Hyla pickeringi*, the tree-toad, *Hyla versicolor*, the leopard- or meadow-frog, *Rana pipiens*, the pickerel-frog, *R. palustris*, the green-frog, *R. clamata*, the bull-frog, *R. catesbiana*, and the wood-frog, *R. silvatica*.

The life-histories of these eight species are very fully described, and are shown to correspond fairly closely with those of their European analogues, on which attention has been bestowed at a much earlier date. Copious notes are given on their first appearance in spring, on their mating, oviposition, and development. Following the example given in the "Tailless Batrachians of Europe," keys are supplied for the identification of the eggs and of the tadpoles. It is to be regretted that the spermatozoa have not been studied. Compared with the European species the tadpole of *R. silvatica* is shown to correspond with that of *R. agilis*, *R. pipiens* and *R. palustris* with *R. arvalis*, *R. clamata* and *R. catesbiana* with *R. esculenta*; *B. americanus* approaches *B. calamita*, and *H. versicolor* *H. aborea*; whilst *H. pickeringi* suggests Bufo in its mouth-parts. Beautiful photographs from life represent specimens in nuptial embrace, the eggs, the tadpoles at various stages of development, males in the act of croaking, etc.

PHYSICS AND ASTRONOMY AT THE BRITISH ASSOCIATION.

THE proceedings of Section A of the British Association in Australia included many interesting papers, and some valuable discussions. The section was fortunate in having a thoroughly representative attendance of English physicists and astronomers, who had made the journey overseas. Amongst those who were present may be mentioned Sir Oliver J. Lodge, Sir Ernest Rutherford, Prof. W. M. Hicks, Prof. A. Gray, Prof. A. W. Porter, Prof. H. H. Turner, the Astronomer Royal, Prof. E. W. Brown, Prof. J. C. Fields, Prof. H. S. Carslaw, Prof. W. E. Cook, and Dr. G. C. Simpson. Dr. C. G. Abbot and Prof. E. Goldstein attended as foreign guests. The local secretaries were Prof. Lyle at Melbourne, and Prof. Pollock at Sydney. The president of the section, Prof. F. T. Trouton, was prevented by illness from making the journey, and his absence was greatly regretted. His duties thus devolved upon the vice-presidents, and Prof. Porter usually acted in his place and bore the brunt of the work. Public interest in the meetings was naturally affected adversely by the outbreak of war, and the attendances at this section were much smaller than has been usual of late years. This was the more unfortunate, because comparatively few papers of a purely specialised and technical character were read, and except on one morning the section was able to meet as a whole.

The meetings opened on Friday, August 14, at Melbourne, with the president's address, which was read by Prof. Porter (see NATURE, August 20, vol. xciii., p. 642). This was followed by the report of the committee to aid the work of establishing a solar observatory in Australia. Prof. Duffield communicated a letter that had been received from the Commonwealth authorities in which it was stated "that in the scheme for the organisation of services in connection with the seat of Government at Canberra, provision has been made for the establishment amongst general astronomical studies of a section to be devoted to solar physics in particular." He also announced that the Premier had consented to receive a deputation from the British Association on the subject. (The deputation, led by Sir Oliver Lodge, waited upon the Premier on the following Tuesday; it was introduced by Mr. Deakin. It was very favourably received, but in the unfortunate circumstances it was felt to be impossible to press for any definite assurances of immediate action.) In this connection a paper on Mount Stromlo Observatory was read by Mr. P. Baracchi, director of Melbourne Observatory. The paper dealt with the suitability of the climatic conditions at Canberra for astronomical work. In 1910 a position was selected about six miles from Canberra, and a small observatory was erected at which observations were made in 1912–13. Evidence was collected which showed that the site was favourable and suitable for the installation of a modern observatory of the first class.

Dr. C. G. Abbot, director of the Astrophysical Observatory of the Smithsonian Institution, read a paper on the variability of the sun. He said that from experiments conducted simultaneously at Mount Wilson, in California, and Bassour, in Algeria, it was found that the intensity of solar radiation (outside the earth's atmosphere) varied through a range of 10 per cent. on different days. The deviations were observed at both stations, so that if, for example, high values were obtained in California, high values were obtained simultaneously in Algeria. The variability is irregular in amount and period, but the range may be as much as 5 per cent. in the course of a week. A connection between the monthly mean values of the solar radiation and the number of sun-spots was also traced, an increased spottedness of the sun's disc being found to correspond with an increased radiation. It appears, therefore, that the sun, besides varying from day to day, varies also from year to year in accordance with the march of the sun-spot cycle. In addition, observations had been made on the contrast of brightness between the centre of the sun's disc and the limb for different wave-lengths; this also appears to undergo an irregular variation similar to the variation of the total radiation. Further researches on these problems are in progress, including some balloon ascents with self-registering apparatus, in which a height of twenty-two miles has been obtained. Dr. Abbot urged the importance of securing the co-operation of stations widely distributed over the globe to eliminate any local atmospheric influences, and he suggested that work in this branch of solar physics might well be taken up by the proposed new observatory in Australia. A long discussion followed the paper, and, in answer to questions, Dr. Abbot explained the general lines of work which he would like to see carried out in Australia. Dr. Simpson and Mr. Gold discussed the bearing of the results on meteorology. Dr. Abbot showed that a close parallelism existed between the spottedness of the sun and the mean temperature in the United States, the main disturbing factor being the presence of volcanic dust in the atmosphere after some of the great eruptions. These two causes accounted for most of the main features of the temperature curve. Prof. Eddington suggested that a similar irregular variability might be looked for in other stars having spectra resembling the sun's; apparently the amount of variation would be sufficiently great to be detected by differential measures of stellar magnitudes.

The morning's proceedings concluded with a paper by Mr. P. Baracchi on the present state of the determinations of Australian longitudes. The stations at Port Darwin and at Southport (Queensland) are the terminals of two chains of telegraphically determined longitudes, one carried eastward and the other westward from Greenwich. The connection between these two meridians obtained by means of measured longitudinal arcs completes a whole longitude circuit of the globe with a closing error of less than 100 ft.

On Tuesday, August 18, a joint meeting was held with Section B (Chemistry), for a discussion on the structure of atoms and molecules. Sir Oliver Lodge presided. Sir Ernest Rutherford, who opened the discussion, directed attention to the recent accumulation of evidence of the independent existence of the chemical atom. It is no longer merely an hypothesis introduced to explain the laws of chemical combination; we are able to detect and count the individual atoms. We can determine the actual mass of an atom certainly to within a few per cent. The idea that the atom is an electrical structure received a great impetus by the detection of the electron by J. J. Thomson; and, moreover, the Zeeman effect showed that it must be in part electrical. The atomic character of negative electricity is well established; we always find the negative electron, however produced, carrying a definite charge. We have, unfortunately, not the same certainty with regard to the behaviour of positive electricity, for it cannot be obtained except associated with a mass comparable with that of a hydrogen atom. In J. J. Thomson's model of the atom the positive electricity was supposed (for mathematical reasons) to be distributed throughout a large sphere with the negative corpuscles moving inside it. This hypothesis played a useful part in indicating possible lines of advance; but it does not fit in with more recent discoveries, which point to a concentrated positive nucleus. We have now two powerful methods that aid us in determining the inner structure of the atom—the scattering of high-speed particles in transit through matter, and the vibrations of the interior parts of the atom. In C. T. R. Wilson's photographs of the tracks of the α particles through a gas, we notice many sudden bends in the paths; in order to account for these deflections it is found necessary to believe that there is a concentrated nucleus atom (having a certain number of units of charge), in which the main part of the mass resides; outside this there are a number of electrons. The whole dimensions of the nucleus are very small indeed compared with the distance of the outer electrons. From the scattering experiments it appears that the law of force right up to the nucleus is the inverse square law; no other formula would give accordance with the observations. The radius of the nucleus is of the order 10^{-12} cm. in the case of gold, and for a lighter element it is smaller still. Another fact that appears from the scattering experiments is that the number of electrons (outside the nucleus) is about half the atomic weight. There is now fairly good evidence that, if the elements are numbered serially in order of atomic weight, the numbers will actually express the charge on the nucleus. The rate of vibration of the inner parts of the nucleus can now be measured by means of the characteristic X-rays emitted. Each substance has two strong lines in its X-ray spectrum, and as we pass from element to element in order of atomic weight the frequencies of these change by regular jumps. H. G.-J. Moseley has investigated all the known elements in this way, and he is even able to show at what points elements are missing, because at such points the X-ray frequencies make a double jump. In this way he has found that between aluminium and gold only four elements are now missing. It is deduced from these considerations that there is something more fundamental than atomic weight, viz., the charge on the nucleus, and that this is the main factor which controls the frequency of the interior vibrations, the mass having only a slight influence. There are certain elements with identical chemical properties, but different atomic weights; thus radium-B (atomic weight 214) and lead (207) are chemically inseparable and have the same γ-ray spectrum. It is quite clear that some new conception is required to explain how the atoms, having the structure we have supposed, can hold together. N. Bohr has faced the difficulty by bringing in the idea of the quantum. At all events, there is something going on which is inexplicable by the older mechanics.

Prof. Armstrong referred to the new attitude with which the chemical elements were regarded; he had long been prepared to believe that they may eventually prove to be compounds. With regard to the existence of elements of different atomic weights chemically indistinguishable, it is too early to conclude that no method of separation and distinction can be devised. The deduction from the X-ray spectra that very few elements are still missing is scarcely justifiable; it may well be that most of those that are known belong to a *preferred type*, and that this particular series is nearly complete. For the chemist any theory of atomic structure must take fully into account the peculiar valency relationships; the system is admittedly one of extraordinary perfection and simplicity; it should be pointed out, however, that so-called structural formulæ are to be regarded as condensed symbolic expressions of the general behaviour and not as representing the actual structure. Thus the conventional representation of benzene by a plane regular hexagon is quite impossible if the affinities of a carbon atom act tetrahedrally. The variable valency of certain elements is another difficulty; the variation seems to be determined by some reciprocal relationship between the interacting elements, valency being a dependent variable and not an absolute property. Fresh significance has lately been given to the problems of valency by the conception, due to Barlow and Pope, that it is to be regarded as a function of the volume occupied by the atom. They have in this way succeeded to a remarkable extent in correlating crystalline form with molecular structure.

Prof. Hicks dealt with the subject from the spectroscopic side, *i.e.* from the consideration of an atom as a configuration capable of emitting definite sets of free vibrations. He reviewed the evidence as to the position of helium in the order of the elements. It is assumed by many physicists, including Rutherford, Bohr, and Moseley, that H and He are consecutive elements, having nuclear charges of one and two units respectively. There are several reasons, however, for supposing that there are places for at least two intermediate elements between them; in particular, the theory of Rydberg requires that the atomic number of helium should be 4. In addition to the electrons and positively-charged nuclei, we have to recognise the presence in certain substances of magnetic doublets the strengths of which are multiples of a definite unit, called by Weiss the magneton; whether the magneton has an independent existence or is a consequence of electronic motion is an open question. The formation of spectral series is a very difficult question; neither Thomson's nor Rutherford's model of the atom has shown any aptitude for explaining spectra, and it would seem that the actual structure must be something much more complicated. There is now a general consensus of evidence, theoretical and experimental, that in the case of series the cause of spectral emission is a change in a few atoms (at any one moment) from one configuration to another, with sudden emission of energy. The contrary view, that it is due to small internal vibrations in all the atoms, presents too great difficulties. It does not follow, however, that the whole of the spectral lines are of the character of the series lines, and Nicholson's theory of the coronium and nebulium spectra points to the existence, under the special conditions in the corona and nebulæ, of emission of a different type. Prof. Hicks also reviewed Bohr's theory of spectra, and, whilst admiring its suggestiveness, pointed out the arbitrary character of some of the assumptions, and its limitation to series of the Balmer type.

Mr. H. G.-J. Moseley explained the results of his classification of the elements by their X-ray spectra. The principal frequency ν is given approximately by the formula $\sqrt{\nu} = \text{constant} \times (N - B)$ where B is a constant and N an integer increasing by a unit as we pass from element to element up the periodic table. The order of the elements determined by N is nearly that of increasing atomic weight; there are one or two exceptions, and in such cases the order given by N is evidently the correct order corresponding to chemical properties. For example, the atomic weight gives the order Cl, K, Ar, whereas the X-ray frequency gives the order Cl, Ar, K. The latter is the order required by the periodic table.

Prof. Nicholson defended the main principles of Bohr's theory. Its most striking success is that it gives with great accuracy two fundamental constants—the universal constant of spectra and (as Prof. Fowler has shown) the mass of the electron in terms of the hydrogen atom. But analysis shows that we cannot obtain other spectra from it, *e.g.* the ordinary helium spectrum, without abandoning at least one of Bohr's premises, which is vital to the deduction of the hydrogen formula. Referring to the elements postulated by him in the corona and nebulæ, Prof. Nicholson was prepared to admit that they might not be chemical elements in the ordinary sense; they might rather be the bases of elements. The atomic weights of these elements have been measured by Buisson and Fabry by an ingenious method and agree with those calculated theoretically from the spectra. Nuclear structure (as distinct from the resultant charge) appears to play a considerable part in series spectra, and, in opposition to Rutherford's view, it seems that the nucleus of a hydrogen atom must be something more complex than the positive electron.

Prof. Bassett discussed the bearing of the periodic law on the number of the elements. The periodicity is not of the simple character at first supposed. There are two short periods of 8 elements followed by two long periods of $(2 \times 8) + 2 = 18$ elements. These are followed by much longer periods, possibly of $(2 \times 18) + 2 = 38$ elements. It is tempting to suggest that hydrogen represents a period of 3 elements, because then the short periods would be represented by $(2 \times 3) + 2 = 8$, following the same rule.

Prof. Kerr Grant summarised the difficulty as to the stability of a system consisting of one nucleus and one electron. It was difficult, too, to account for the non-magnetic character of the hydrogen atom with this structure.

The discussion occupied the whole morning, and was followed with keen interest. So many different points of attack on the problem were represented that it could scarcely be expected that any one aspect would be argued out to a conclusion by the different speakers, but, regarded as a symposium, the discussion provided a most useful survey of the present state of our knowledge. A full report is to be printed in the annual volume of the British Association.

The section met again in the afternoon, when Prof. E. Goldstein read a paper on salts coloured by the kathode rays. When the rays fall on certain salts coloration is produced immediately. These colours disappear on prolonged exposure to daylight or when the salt is heated; the rate of disappearance varies greatly for different substances. The characteristic colour and the behaviour on heating afford a means of identifying the substance, and impurities present in very minute quantities can often be discovered in this way, for a very small admixture of the salt suffices. It was at first supposed that the phenomenon was due mainly to a chemical reduction; Giesel and Kreutz obtained analogous colours by exposure of the salts to the vapour of sodium and potassium. But there are important differences between the Giesel colours and those here considered. For example, the former are much more stable when exposed to daylight. Prof. Goldstein showed that stable coloration identical with that obtained by Giesel can indeed be produced by the kathode rays, but as the result of prolonged bombardment in which the salt becomes heated strongly. He calls these "after-colours of the second class" to distinguish them from those of the "first class," which appear immediately on exposure. The colours of the first class depend not only on the metal, but on the acid constituent; indeed, they can be produced in some organic salts which contain no metallic base. There can thus be no question of chemical decomposition; but apparently the matter passes into some changed—possibly polymerised—state which deserves a careful study. Amongst other things the new state is characterised by greatly increased absorption of light. Connected with the loss of coloration by exposure to daylight there is generally a phosphorescence, which follows the exposure. It is possible to produce the same colours by ultra-violet light, and probably the action of the kathode rays is not direct, but is due to the radiation of ultra-violet light by molecules struck by them. The destruction by the longer waves of daylight of effects produced by the light of short wave-length is a phenomenon of which many other examples occur. The paper was illustrated by specimens of the coloured salts.

Prof. Hicks spoke on the magneton as a scattering agent for α and β particles. The paper dealt with the orbits of charged particles coming into the field of the magneton and the nature of the scattering was explained. Prof. T. R. Lyle gave a demonstration of a mechanical analogue of wireless telegraph circuits.

On Wednesday morning a discussion took place on the problems of Antarctic meteorology. The meeting was fortunate in having the attendance of a number of men of science who were personally familiar with the Antarctic regions. Dr. G. C. Simpson, who opened the discussion, dealt with the main problem of the general circulation of the atmosphere in the southern hemisphere. Dr. Lockyer has suggested that there is an intense anticyclone over the Antarctic continent from which cold air feeds into a ring of large cyclones having their centres about 60° S., and extending northwards as far as 40° S. Prof. Meinardus also has postulated a series of cyclones over the Southern Ocean travelling from west to east; but he finds it difficult to accept anticyclonic conditions over the continent, owing to the great excess of precipitation there which gives rise to the glaciers and snowfields. From a detailed discussion of the conditions in the Ross Sea area Dr. Simpson deduces that the conditions over the continent are anticyclonic. In the lower atmosphere the strong south-easterly blizzards are the result of the large differences of temperature between the barrier and the Ross Sea. In the upper atmosphere the air feeds in again to the Antarctic, as is shown by the cloud observations. Meinardus's objection that in such a circulation the precipitation would not exceed the evaporation is met by a consideration of the great cooling of the air due to radiation. With regard to the existence of a belt of cyclones over the ocean, it appears quite impossible to reconcile wind and barometer observations with any circulation of wind about a low-pressure centre moving from west to east. Further the simultaneous barometer readings at Melbourne, New Zealand, and Cape Adare give no certain indication of the same cyclone affecting the northern and southern stations. Dr. Simpson pointed out an important negative correlation between the pressure at Cape Evans and in Australasia, and urged the importance for Australian meteorology of extensive observations on the Antarctic continent.

Mr. Griffiths Taylor pointed out the importance of the proximity to Australia of this colossal source of cold energy. The Antarctic continent is a much greater land-mass than the Tibetan Plateau; the latter controls the monsoons and has an enormous effect on the Indian climate. Meteorologically the influence of the Antarctic tableland must be a most important fact. Mr. Hunt, Captain Davis, Mr. H. T. Ferrar, Prof. Rudmose Brown, and Mr. Gold also took part briefly in the discussion.

Prof. H. H. Turner then gave an account of the work of the Seismological Committee, referring particularly to the situation of difficulty and anxiety created by the death of Prof. Milne. Progress has been made in the study of the distribution of earthquake centres, and Prof. Turner exhibited a map showing the geometrical relation of these to the land distribution on the globe.

The sitting terminated early, as the members had to leave for Sydney in the afternoon.

The meeting at Sydney opened on Friday, August 21. Sir E. Rutherford spoke first on the origin and nature of the γ rays from radium. Dr. Dyson then read a paper on the stars near the north pole. So far as proper motion is concerned, the area within 9° of the pole is more thoroughly known than any other part of the sky, since the stars down to a faint limit of magnitude, 3700 in number, were observed by Carrington about 1855, and have been re-observed at Greenwich forty-five years later. This region has also been well studied as regards magnitudes, both photographic and visual, the photographic determinations having been made at Greenwich and the visual determinations at Potsdam. From the difference between the photographic and visual magnitudes (called the colour-index) a classification according to spectral type is possible. The proper motions of these stars have been discussed by a statistical method with the view of finding the distribution of the stars in space, particular attention being paid to the differences shown when the stars are grouped according to colour-index. The results which were given by Dr. Dyson are too complex to be summarised here. They bring out in a very striking way the fact that the reddest stars are in the mean at a great distance from us—farther even than the white stars—and that it is the stars in the middle of the spectral series (types F and G) that are closest to the sun. There is good evidence of a considerable diminution in the density of the distribution of the stars between the distances of 100 and 500 parsecs, and the numerical results agree substantially with the diminution found by Kapteyn.

Messrs. Petrie and Chapman gave an account of a curious actinic effect of the juice of *Euphorbia peplus*. The dried juice acts on a sensitive photographic plate in the dark. The effect can be transmitted through black paper impervious to light or through thin aluminium or gold foil. Yet no action on ionised air can be detected with an electrometer. The property is retained after prolonged heating, and a sample dried five years ago is still as active as ever. The juices of many other species of Euphorbia and similar plants have been tested, and have been found to have no comparable action.

Prof. A. Gray read a paper on the attractions of ellipsoidal shells. The principal theorems in the attractions of ellipsoids were deduced by a new and elegant geometrical method.

Papers were also read by Prof. O. U. Vonwiller on the photo-electric effect in selenium, and by Prof. W. G. Duffield on the pressure upon the poles of a carbon arc.

The next meeting was on Monday afternoon, August 24. Prof. Turner gave a paper on discontinuities in meteorological phenomena. The usual methods of harmonic analysis proceed on the assumption that the periodicities looked for persist through the time covered by the observational data. In the case of certain astronomical phenomena, particularly the sun-spot cycle, Prof. Turner had arrived at the conclusion that abrupt discontinuities took place from time to time, a change of period taking place at the discontinuity. A simple method was described by which such discontinuities could be detected, and the evidence suitably exhibited. The method was illustrated by applying it to rainfall and other meteorological data for which long records were available. Breaks in the period are found to occur about every seven years. These critical years were determined independently from three separate sets of data, and a good general agreement exists between them.

Prof. Eddington gave an account of a determination of the oblateness of the stellar system. It is well-known that the distribution of the stars is decidedly flattened towards the plane of the Milky Way, and recent counts of stars, made by Chapman and Melotte at Greenwich, provide a means of making a numerical estimate of the amount of flattening. These statistics extend so far as the seventeenth magnitude, and are directly referred to standard photographic magnitudes. Although magnitude-counts alone are not sufficient to determine the general law of density of distribution of the stars at different distances, yet by comparing the counts in the galactic plane and near the galactic poles the general shape of the surfaces of equal density can be found. The average oblateness is about 1 : 3·5, that is to say, the same falling off in density will be found $3\frac{1}{2}$ times as far away in directions in the galactic plane as at the galactic poles. But the oblateness is not uniform; at greater distances the surfaces of equal density are less flattened; the number given refers to a distance equal to the average distance of stars of about the eleventh magnitude. This value of the oblateness is considerably higher than was anticipated. The Milky Way itself is not included in this estimate, and it probably forms a flat girdle outside the oblate system considered in the paper.

The concluding sitting of the section on Tuesday morning, August 25, attracted a very large attendance, the room being filled to overflowing. Sir Oliver Lodge opened a discussion on radio-telegraphy; he was followed by Mr. Balsillie, Prof. Howe, Dr. Eccles, and others. The meeting was held jointly with Section G (although, owing to their heavy programme, that section was also meeting independently at the same time), and an account of the discussion has appeared in NATURE under the proceedings of the Engineering Section. The large attendance was a tribute to the personality of the opener, but the subject evidently appealed strongly to the general public; from the scientific point of view it was equally satisfactory, and many points of great interest were brought forward.

After the discussion, Prof. Pollock gave an account of some measurements of the wave-length in air of electrical vibrations associated with a thin terminated straight rod.

Mr. Moseley read a paper on high-frequency spectra. The references in the discussion on the structure of the atom to the remarkable results derived from X-ray spectra had aroused much interest; and this fuller account of his researches—postponed from a previous day—was eagerly anticipated. He described the production of the characteristic X-rays of the substance by Kaye's method, and the measurement of their wave-length by reflection of the image of a slit from the surface of a crystal. The elements (from aluminium to gold) were numbered in order with a few gaps left for missing elements; taking this atomic number as ordinate and the square root of the X-ray frequencies as abscissæ, the resulting curves are practically straight lines. In most cases there are two lines in the spectra, and the frequencies of the strong component lie along one straight line in the diagram, those of the weak components along another. It is found (in order to preserve the continuity of the straight lines) that a number must be left vacant for a missing element of the manganese series between molybdenum and ruthenium, and another between tungsten and osmium. These gaps are also indicated by Mendeléeff's table. Much confusion exists in the rare earths as to how many separate elements exist, and the method is able to throw light on this question; there is one element missing between neodymium and samarium. A recent addition to the elements—celtium—is not confirmed by this investigation; the X-ray spectrum indicates that it is a mixture of previously known earths

Prof. Porter read a paper by Mr. Paris and himself on the scattering of light by small and large particles of conducting and non-conducting substances. Suspended particles of sulphur, silver, and copper were used, and the intensity and degree of polarisation of the light scattered in different directions were measured. For the metallic particles, the size could be determined; the diameters in different experiments ranged from 80 to 310 $\mu\mu$. From the direction of maximum polarisation the conductivity of the particles could be measured. It appears that the conductivity diminishes with the size of the particles; and it is suggested that the number of free electrons present in the finely divided metal is smaller than when the material is in mass.

Dr. Rankine described methods of measuring the viscosities of chlorine, bromine, and iodine at a number of different temperatures He discussed the relations between the viscosities of the three gases and showed that they correspond with laws which he had previously found to apply to the inert gases.

During part of this final morning the department of mathematics met separately, Prof. Carslaw presiding. The following papers were read:—Mr. Chaundy, "Symbolic Solution of Linear Partial Differential Equations of the Second Order"; Prof. Fields, "Properties of Algebraic Numbers Analogous to Certain Properties of Algebraic Functions"; Prof. Carslaw, "The Green's Function for the Equation $\Delta^2 u + k^2 u = 0$"; Prof. Hudson, "The Evolute of the Limaçon"; Mr. Macaulay, "The Algebraic Theory of Modular Systems"; Mr. Macaulay, "A Property of Double Points."

Several papers were taken as read during the different sittings. These included a number of local papers, the authors of which were unable to attend. Mr. Herens and Prof. Laby had a paper on an absolute determination of the thermal conductivity of air; Prof. Laby and Mr. Stuart on the nature of γ rays; Prof. Laby and Mr. Adams on the electric resistance of steel tapes; Mr. Hogben, a map of the principal earthquake centres of the south-west Pacific; Mr. Kidson on the general magnetic survey of Australia; Prof. Laby and Mr. Herens on the thermal conductivity of air; Prof. Porter and Mr. Simeon on the change of thermal conductivity during the liquefaction of a metal; Mr. Wellisch on experiments on the active deposit of radium. These papers were all taken as read.

A brief reference must also be made to other activities of the section, outside the ordinary meetings for papers and discussions. To meet the special circumstances of the Australian meeting an extra sitting of the section was arranged at Brisbane, when Prof. E. W. Brown delivered an address on the motion of the moon. Evening discourses and public lectures on physical and astronomical subjects were delivered during the visit by Sir O. Lodge, Sir E. Rutherford, Prof. Turner, Dr. Dyson, and Prof. Eddington. At Sydney the local Astronomical and Mathematical Societies held special meetings which many of the visitors attended and took part in, and in more informal ways the members found much scope for useful activity outside the official programme. A sub-committee, under the chairmanship of Prof. Love, organised a series of experiments to be carried out during the voyage to Australia, and a number of the visiting physicists undertook to utilise the opportunity in this way. No official information as to this work is as yet to hand, but we understand that a good deal was accomplished. Of special interest was Prof. Duffield's investigation of the value of gravity at sea by means of Hecker's apparatus; the experiments were carried out on the outward voyage on the *Ascanius*, the owners (Alfred Holt and Co.) having made very generous provision of facilities for the work.

BOTANY AT THE BRITISH ASSOCIATION.

THE botanical benefits derivable from a visit to Australia began to manifest themselves as soon as we left the shores of England. Taking advantage of the facilities offered by the Blue Funnel Line, it was possible, as a member of the advance party on board the *Ascanius*, to make collections of the plankton daily throughout the voyage from England to Australia, by the Cape.

The writer made qualitative collections with the help of apparatus provided by Prof. Herdman, whose quantitative work went on in spite of the rough weather in the "roaring forties" which laid Dr. Ostenfeld low with a comminuted left patella, to the great regret of all, and especially of the botanists whose invited guest he was. His absence from the field and from the meeting in Australia was felt throughout our visit.

A call at Las Palmas and at Cape Town, of a few hours' duration only, in each case, allowed us to see something of the flora of the Canaries and of Cape Colony respectively. The forests of the silver-leaf tree—*Leucadendron argenteum*—covering the slopes of Table Mountain, were a striking feature in the fine drive of fifty miles on the coast road at the Cape. The time spent in responding, on our first day out, to the S.O.S. signal of the *Gothland*, on the Bishop Rock in the Scilly Isles, could not be made up owing to rough weather east of the Cape, so that we missed the garden-party of 2500 invited by the Governor to meet us at Perth, and we arrived only just in time for the delivery of Prof. Herdman's lecture on "Why We Study the Ocean."

Elaborate preparations had been made to enable us, by train and motor-car, to see something of the types of flora in different parts of West Australia under the able, constant, and ideal guidance of Mr. C. Andrews. Botanists owe him a deep debt of gratitude for placing his thorough knowledge of the flora, as well as his time, so readily at the disposal of the party. Mr. Andrews added to our obligations by writing a well-illustrated article on the flora of West Australia for the Handbook of the State, of which each member received a copy. With such a rich flora (4000 species), of which two-thirds is endemic, a week was tantalisingly little, and we could do little more than note, and collect for subsequent study, specimens of the striking xerophilous, endemic flora made famous by the researches of Robert Brown, J. D. Hooker, Diels, and others. The Proteaceæ, Myrtaceæ, Leguminosæ, and Rutaceæ are orders which stand out by their frequency and ecological adaptations. The flora round King George's Sound at Albany proved a great treat. *Cephalotus follicularis* and *Phylloglossum drummondii* (a club-moss most botanists have never seen living), in plenty, *Boronia megastigma* as abundant as a meadow grass, Xanthorrœa and Kingia in various stages of development, *Macrozamia fraseri*, Eucalyptus of many kinds and limitless in quantity, must suffice to suggest the richness of the botanical features enjoyed.

It was fortunate in one sense that we were, we learnt, six weeks too soon for the blaze of colour and variety of form characteristic of the early summer of West Australia. It is not too much to say that nothing in the whole meeting exceeded the hospitable welcome and generous excursion arrangements made by the Government and people of this State. We returned from the scrub to find the war clouds bursting and to see in Perth a fine illustration of patriotic feeling indicative of the unity of the British Empire.

There was so much of interest on every side that early in our visit it was realised it would be wise to economise our plates by systematising the photographic work of the party. Dr. Holt, the Recorder of chemistry, accordingly suggested a selective distribution of the work, with a subsequent exchange of prints. This idea was extended by the writer to cover the work of the different sections throughout the visit to Australia. A note was inserted in the Journal inviting photographing members to co-operate; and many promised their support.

The botanists were particularly fortunate in finding at all the centres visited preparations made for excursions to districts characteristic of the local flora. To Prof. and Mrs. Osborn we owe a deep debt of gratitude for their help and hospitality at Adelaide. The visits to the mangrove swamp (Avicennia), at the Grange (Henley Beach), to Mt. Lofty Range, and through the Mallee scrub to Mannum, are three excursions not likely to be soon forgotten, made more instructive by the maps and notes prepared by Prof. Osborn.

It was not until we reached Melbourne that the Botanical Section (K) came officially into existence. So far we had been fully occupied in the field. Here, as later at Sydney, it was difficult to find time for the many valuable contributions offered. Miss E. R. Saunders, a vice-president of the section, gave a lecture on a common garden plant, its history and behaviour, illustrated by lantern-slides. This was followed by a well-illustrated account by Dr. C. J. Bond on sex dimorphism in some abnormal begonia flowers. Prof. A. J. Ewart and Miss O. B. Davies described the flora of the Northern Territory, Mr. C. S. Sutton that of Melbourne, while Mr. Hiern contributed a paper on the Australian Ebenaceæ. Contributions were also made by Prof. F. O. Bower, the president of the section ("Modern Derivatives of the Matonioid Ferns"), by Prof. Ewart ("Oxidase Enzymes"), by Miss E. N. Thomas and Miss A. J. Davey ("The Seedling Anatomy of certain Pseudo-Monocotyledons"), Dr. E. N. Berridge ("Casuarina"), Miss Rees ("Fossil Fruits"). Prof. Gunner Andersson, of Stockholm, suggested a field of work for Australia in his account of the climate in northern temperate and arctic zones during the latest Pleistocene age. Dr. Ostenfeld's paper on the geographical distribution of the sea-grasses, in which he directed attention to the incompleteness of the knowledge of Australian forms, was communicated by Dr. Rendle, who initiated a joint discussion with Section D (Zoology) on the origin of species. This formed one of the most interesting features of the Melbourne meeting, and took place before a crowded audience. A general report will follow.

Prof. Seward's lecture on the fossil plants discovered by Capt. Scott's last expedition in the Antarctic regions aroused much interest. Miss Lorrain Smith described the relationship of fungus and alga in the lichen thallus, and concluded that the relationship is one of nutrition. The fungus is certainly dependent on the alga, but the alga is dependent on the fungus for its nitrogen and partly for its carbohydrates. The botanical excursions at Melbourne proved highly attractive. The outstanding one, for elaborateness of preparation, was that to the National Park, a great national reserve of 150,000 acres, reached by rail, boat, and horseback from Melbourne. To Prof. Ewart and his assistant, Mr. O'Brien, to Mr. Kershaw, curator of the museum, Mr. Catani, and Mr. Audass, botanists owe many thanks for the success of the Melbourne portion of the Australian visit.

The presidential address, already reprinted in NATURE, was reserved for Sydney. This was followed by a series of papers on Eucalyptus, contributed by Messrs. J. H. Maiden, R. T. Baker and H. E. Smith,

R. H. Cambage and Dr. Cuthbert Hall. Time, and Mr. Maiden's too numerous duties as local secretary, prevented adequate discussion of these valuable papers on one of Australia's most variable, abundant, and adaptable genera.

Prof. Seward represented the section in a joint discussion with Sections C, D, and E on the past and present relations of Antarctica. A verbatim report of this debate was authorised by the council.

Prof. Margaret Benson spoke on recent advances in our knowledge of Sigillaria. Papers were also contributed by Prof. T. G. B. Osborn on types of vegetation on the coast in the neighbourhood of Adelaide, and on the life-history of *Ophiobolus graminis,* by Mr. A. G. Hamilton, a well-known local botanist, on the xerophytic characters of *Bossiaea scolopendria.*

Dr. J. B. Cleland described certain features in the spores of Basidiomycetes. Mr. F. Turner illustrated his botanical survey of New South Wales by many specimens, as did Mr. R. P. Gregory in the account of his investigations on inheritance in certain giant races of *Primula sinensis.* A long motor drive through fine scenery to Bulli, the source of Sydney's water supply, under Mr. Maiden's guidance, proved a charming addition to our excursion experiences. Field excursions in plenty, systematic botany contributions, especially by botanists working in Australia, valuable Mendelian contributions in this Mendelian year, seem to be the outstanding features of the Botanical Society's activities in Australia. Some of us had the good fortune to visit Brisbane, Townsville, Cairns, Port Darwin, Java, Peradeniya, and Singapore, in nearly all of which not only was the local flora seen, but also the botanical gardens were visited. To Mr. F. M. Bailey, the Government botanist of Queensland, and his family, to Mr. Shirley, and to Mr. Burkill, of Singapore, we owe thanks for many kind attentions. At all "call" places on our way home we were welcomed, entertained, and shown features of botanical interest, making it not a little difficult to settle down once more to normal life. T. J.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LIVERPOOL.—Dr. W. Ramsden, senior demonstrator in physiology, University of Oxford, has been elected to the Johnston chair of biochemistry in the University rendered vacant by the resignation of Dr. Benjamin Moore.

LONDON.—The resignation of Prof. F. T. Trouton, F.R.S., from the professorship of physics at University College has been accepted by the Senate.

More than 1000 applications for commissions in the Army have been forwarded to the War Office from cadets and ex-cadets of the University contingent of the Officers Training Corps, and other students and graduates since the outbreak of war.

Sir Alfred Pearce Gould is acting as Vice-Chancellor during Sir Wilmot Herringham's absence at the front.

THE Rev. Dr. J. P. Mahaffy has been appointed Provost of Trinity College, Dublin, in succession to the late Dr. Traill.

IT is stated in *Science* that Mr. W. K. Vanderbilt has given 27,150*l.* toward the purchase by Columbia University of a half block of land adjoining other land owned by the university; and that the University of Pennsylvania receives 10,000*l.* by the will of the late Miss Anna Blanchard, of Philadelphia.

THE Department of Agriculture and Technical Instruction for Ireland is offering for competition in 1915 among students of science and technology a limited number of scholarships and teacherships-in-training tenable at the Royal College of Science, Dublin. The scholarships are of the value of 50*l.* per annum, and, in addition, entitle the holder to free instruction during the Associate course, and third-class railway fare for one journey each session to and from Dublin. A teachership-in-training entitles the holder to free instruction during the Associate course, a maintenance allowance of 21*s.* per week for the session of about forty weeks each year, and third-class railway fare for one journey each session to and from Dublin. Candidates must have been born in Ireland, or have been resident in Ireland for three years immediately prior to June 1, 1915. They have to satisfy the Department as to their knowledge of English and of one other language. Applications for admission to the examination must be made not later than April 29, 1915, on Form S. 34, copies of which may be obtained upon application to the Secretary, Department of Agriculture and Technical Instruction for Ireland, Upper Merrion Street, Dublin, or to the Registrar, Royal College of Science, Upper Merrion Street, Dublin.

THE report on the work of the Department of Technology of the City and Guilds of London Institute for the session 1913–14 has now been published. At the recent examinations, 23,119 candidates were presented in technology from 467 centres in the United Kingdom, and of these 14,570 passed. These figures show an increase of 1241 in the number of examinees, and of 952 in the number of those who passed. By including 753 candidates from India, from the overseas Dominions, and from other parts of the British Empire, 998 candidates for the special examination in magnetism and electricity, held by arrangement with the Postmaster-General, 67 for special examinations in cookery and needlework, and 1839 for teachers' certificates in manual training and domestic subjects, the total number examined was 26,776. The report states there can be no doubt that the teaching of technology has improved greatly during the past few years; but it is noted that the examiners have still to direct attention to the insufficient knowledge that some candidates possess of the principles of their subjects, and to the lack of practical knowledge shown by others, and they think the unsatisfactory answers in consecutively numbered papers which have been found to be the work of students of the same class indicate faulty teaching as the source. The purpose of technical instruction being the better training of the artisan to understand and appreciate the scientific principles that underlie his trade or craft, the attention of teachers should especially be directed to the necessity for a more thorough training of students in fundamental principles. The inability of candidates to express themselves clearly is perhaps not so noticeable as in past years, but the examiners have again to point out the difficulty that simple mathematical calculations present to many candidates —a defect which can only be attributed to insufficient preliminary training.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 12.—Sir William Crookes, president, in the chair.—W. L. **Balls** and F. S. **Holton**: Analyses of agricultural yield. Part I.—Spacing experiments with Egyptian cotton. The aim of the experiments is the statistical analysis of the yield of agricultural crops, in terms of plant development, by careful recording of all stages. The effects of environmental conditions on crop development can then be satisfactorily analysed. The effects of varying spacing, date of sowing, and season, upon Egyptian cotton, have been subjected in this way to critical examination by the authors. A secondary aim has been to appreciate the reasons for conventional agricultural practice. For each of twenty different spacings, the numbers of flowers daily, and of fruits, together with the weights of cotton and seed per fruit, have been recorded. The extent to which each of these components enters into the building up of the final yield is shown. The dense planting conventionally practised by the Egyptian fellah is shown to give the maximum possible yield per unit area under the limitations of field cultivation, though the normal extension of the root-system of an isolated plant can utilise more than ten times the soil-surface allotted to it in field-crop. Most of the phenomena of field-crop physiology in the fruiting season are thus shown to be traceable to root-interference.—J. **McIntosh** and P. **Fildes**: The fixation of arsenic by the brain after intravenous injections of salvarsan. After intravenous injections of salvarsan and neosalvarsan in man and animals no arsenic can be found in the brain. This phenomenon is not due to lack of affinity between the brain and the drugs, but to an inability on the part of the drugs to penetrate into the substance of the brain. Fixation of arsenic by the brain occurs as readily as by the liver, as shown by experiments *in vitro* and the toxic effects of intrathecal injections. Penetration of neosalvarsan into the brain cannot be obtained even by frequently repeated intravenous injections.—A. E. **Everest**: The production of anthocyanins and anthocyanidins. Part II. The author brings forward further evidence to support the conclusions arrived at by him in his previous paper (Roy. Soc. Proc., B, 1914, vol. lxxxvii., p. 144), namely, that the red, blue, and violet flower and fruit pigments (anthocyans) may be produced by reduction of flavone and flavonol derivatives in acid solution. Experiments are described which show that pure disaccharides of the flavonol series pass without hydrolysis to anthocyanins. The flavone and flavonol pigments having been previously synthesised by Kostanecki, the processes described by the author complete the synthesis of the anthocyan pigments.—H. M. **Woodcock** and G. **Lapage**: Living observations on the life-cycle of a new flagellate—*Helkesimastix faecicola*—together with remarks on the question of syngamy in the trypanosomes. *H. faecicola*, ng., n.sp., occurs in goat-dung and sheep-dung; it is a "passenger," being carried through the alimentary canal in an encysted state. The authors have cultivated this flagellate in various media. They have observed the entire course of the life-cycle in life, from excystation to encystment.—S. W. **Patterson**: The antagonistic action of carbon dioxide and adrenalin on the heart. Carbon dioxide alone depresses all the functions of the isolated heart. Adrenalin, besides dilating the coronary vessels, has a specific action in increasing the rate and strength of ventricular contraction. The effect of carbon dioxide and adrenalin combined is still to allow of more rapid and stronger contraction and rapid relaxation, and also to lengthen the diastolic period. Thus, greater filling of the heart takes place, and the heart is in a better condition for putting out a maximal output.

Zoological Society, November 10.—Prof. E. W. MacBride, vice-president, in the chair.—R. I. **Pocock**: Some unrecorded structural differences between the pine-marten (*Martes martes*) and the beech-marten (*Martes foina*). The two species, apart from the known differences in the skull and teeth, may be distinguished by the size of the ears, which are broader and longer in *M. martes* than in *M. foina*, and by the dimensions of the pads on the feet, which are considerably larger and less overgrown with hair in *M. foina* than in *M. martes*.—Dr. F. E. **Beddard**: Anatomy and systematic arrangement of the Cestoidea. A new genus and species of the family Acoleidæ was described, based upon a large number of examples obtained from the Canadian tree-porcupine (*Erethizon dorsatum*.—H. R. **Hogg**: Report on the spiders collected by the Wollaston and British Ornithological Union Expeditions in Dutch New Guinea. This collection confirms a good deal of the work of previous authors, and at the same time brings to light much that is new. Leaving out the Attidæ, there are representatives of nine families, comprising twenty-six genera (of which one is new) and forty-five species or subspecies of which some nineteen are new.

Physical Society, November 13.—Dr. A. Russell, vice-president, in the chair.—D. **Owen**: A bridge for the measurement of self-induction. An alternate-current bridge method is proposed for the determination of self-induction in terms of capacity and resistance. The inductance L is given by the relation $L=K_3r_1R$; in addition to which it is also necessary for balance of the bridge to satisfy the condition $K_3r_1=K_4r_2$. The conditions of balance may be secured without mutual interference. The end point is rapidly attained. The possibility of effecting a balance is unlimited by the value of the unknown L. The method is independent of frequency, and it is unnecessary to employ a pure sine voltage. Good results may be attained with a buzzer as source and a telephone receiver as detector. The dependence of sensibility of the bridge on the frequency is discussed, and over a wide range the sensibility is high. The effects of residual inductance in the resistance coils and leads, and of absorption in the condensers, may be allowed for, the formula then becoming $L=K_3r_1(R-R_0)$. Tests are quoted showing that with the same pair of condensers measurements over the full range from one microhenry upwards may be made. For inductances of the order of 10 microhenries the error may be kept within a few parts in 1000; whilst if the inductance is as high as a few millihenries the error of any measurement may be reduced below one part in 10,000. The application of this bridge to the determination of capacity in terms of self-inductance is discussed, and an example is given of a test of the temperature variation of capacity of a standard mica condenser over the range 0°–30° C.—B. W. **Clack**: The coefficient of diffusion in dilute solutions. Modifications have been made in the apparatus previously described to determine the value of the coefficient of diffusion of salts through water, by means of which the steady state is hastened and results obtained more quickly. The single wide tube previously employed is replaced by a battery of shorter and narrower tubes. The error due to end-correction is investigated and results are given for the salts KCl, KNO_3, and NaCl for various concentrations down to very dilute solutions.

Royal Meteorological Society, November 18.—Dr. H. N. Dickson, vice-president, in the chair.—Dr. H. R. **Mill** and C. **Salter**: Isomeric rainfall maps of the British Isles. The average monthly rainfall expressed as a percentage of the average annual fall of each of about 300 stations forms the basis of a set of twelve monthly and four seasonal maps. The most striking features are the occurrence of two types of seasonal march; one chiefly characteristic of western or wet districts, having a winter maximum and a summer minimum, the other chiefly confined to eastern or dry districts, having a winter minimum, and a summer or autumn maximum. The equinoctial maps show the transitional stages between these two extremes, the spring months having everywhere a low rainfall and small range with a central maximum inland and a peripheral minimum on the coast, and the autumn months a large rainfall with a central minimum and a peripheral maximum. The maps show that the relation of heavy rainfall with high-lying land is a relation of cause and effect, the relation of the winter maximum with the heavy rainfall is therefore an indication of a common cause. High land is only associated with heavy rain because it meets rain-bearing winds, and the true connecting circumstances are the position of high land and its relation to the prevailing winds. The occurrence of rain with easterly winds, affecting principally the east coast, makes it impossible to view the British Isles as having a rainfall *régime* solely produced by south-westerly winds. The far greater frequency of southerly and westerly winds than of easterly and northerly, and the fact that the latter occur mainly at certain seasons, go far to explain the features both of the average rainfall maps and of the isomeric maps.—J. I. **Craig**: A see-saw of temperature between England and Egypt. Diagrams were given of lines of thermal equi-correlation with Egypt.

PARIS.

Academy of Sciences, November 9.—M. P. Appell in the chair.—Emile **Picard**: Concerning the hydrodynamical paradox of d'Alembert. Remarks on a recent note by M. Pierre Duhem.—Pierre **Duhem**: Remark on the hydrodynamical paradox of d'Alembert.—A. **Laveran**: Remarks on the prophylaxy of typhus in armies in the field. That the infection of typhus is carried by lice has been proved by Nicolle at Tunis, and confirmed by American physicians in Mexico. Under the conditions necessitated by fighting in trenches the chance of an epidemic is greatly increased. Special importance, therefore, attaches to personal cleanliness in the troops at the front.—M. **Balland**: The preservation of food for army service. A method has been proposed according to which meat, rice, and agar-agar are sealed in a tin, the cooking being carried out after sealing the tin. It is pointed out that the official method in the French Army, in which the meat is cooked before canning, gives a more concentrated product, and the addition of rice and agar-agar is deprecated.—A. **Brachet**: The action of butyric acid upon the development of the eggs of the sea-urchin.—H. **Bourget**: Observations of the transit of mercury across the sun made at the Observatory of Marseilles. Observations of the contact times were carried out under good atmospheric conditions.—D. **Eginitis**: Observations of Delavan's comet made at the Athens Observatory with the Doridis equatorial (Gautier, 40 cm.). Positions given for September 18, 19, and 30, and October 1. The comet was visible to the naked eye, with a tail of 5°, and of apparent magnitude 5.—B. **Globa-Mikhailenco**: Equilibrium figures of a fluid mass in rotation, infinitely near an elliptical cylinder.—A. **Mesnager**: A rapid method for the calculation of arches. A diagram is given for the rapid graphical determination of the bending moment.—Charles **Rabut**: The Eauplet bridge and the deformation of arcs.—M. **Amans**: The problem of flight.—F. **Garrigou**: A simple method of obtaining the notion of relief in radioscopy.—Louis **Gentil**: The structure of the plateau of Oulmès, Central Morocco.—Charles **Nicolle**, G. **Blanc**, and E. **Conseil**: Some points in the experimental study of exanthematic typhus. The lice do not transmit the disease before the eighth day after infection; they transmit it on the ninth and tenth day after infection. This was also found to be the case with the excreta of lice nourished on infected blood. Experiments on hereditary infection in lice gave negative results in all cases.—MM. **Caillaud** and **Corniglion**: Contribution to the study of the treatment of tetanus. The treatment adopted for two cases was a daily intra-muscular injection of 1 per cent. solution of carbolic acid, either alone, or in conjunction with (for two graver cases) intra-venous injection of lantol or colloidal rhodium. All four cases were cured, although two other cases treated with anti-tetanic serum and chloral died after three days. In the four patients cured the definite symptoms of tetanus were well developed before the treatment was started. The same method has also been successfully applied to five cases of tetanus at Cannes. In all there have been nine cures in nine cases.—Aug. **Lameere**: The male of Dicyema.

BOOKS RECEIVED.

Proceedings of the Edinburgh Mathematical Society. Vol. xxxii. Session 1913–14. Pp. viii+168. (Edinburgh: Mathematical Society.) 7*s.* 6*d.*

Manchester Astronomical Society. Journal of the Session 1913–14. No. 1. Pp. x+43. (Manchester: Astronomical Society.) 2*s.*

A Geography of Australasia. By G. Taylor. Pp. 176. (Oxford: Clarendon Press.) 1*s.* 6*d.*

The Indian Museum, 1814–1914. Pp. xi+136+lxxxvii. (Calcutta: Indian Museum.)

The Psychological Researches of James McKeen Cattell. A Review by some of his Pupils. (Archives of Psychology, No. 30. April.) Pp. v+101. (New York: The Science Press.)

Transactions of the Institution of Engineers and Shipbuilders in Scotland. Vol. lviii. Nov. Part i. (Glasgow: Institution of Engineers and Shipbuilders.)

The Master-Key: a New Philosophy. By D. Blair. Pp. vi+118. (Wimbledon: Ashrama Agency.) 3*s.* 6*d.* net.

Bulletin No. 12. The Indian Association for the Cultivation of Science: Iron in Ancient India. By Prof. P. Neogi. Pp. x+78. (Calcutta: Indian Association for the Cultivation of Science.) 3*s.* net.

Canada. Department of Mines. Geological Survey Branch. Memoir No. 20 E.: Gold Fields of Nova Scotia. By W. Malcolm. Pp. xvi+331+Maps. Memoir 42: The Double-Curve Motive in North-eastern Algonkian Art. By F. G. Speck. Pp. 17+Figs. 25+Plates xviii. (Ottawa: Government Printing Bureau.)

University of Bristol. Calendar, 1914–15. Pp. 324. (Bristol: The University.)

Stability and Equilibrium of Floating Bodies. By B. C. Laws. Pp. ix+251. (London: Constable and Co., Ltd.) 10*s.* 6*d.* net.

A Manual of Weeds. By A. E. Georgia Pp. xi+593. (London: Macmillan and Co., Ltd.) 8*s.* 6*d.* net.

Food Products. By Prof. H. C. Sherman. Pp. ix+594. (London: Macmillan and Co., Ltd.) 10*s.* net.

History of Upper Assam, Upper Burmah, and North-Eastern Frontier. By Col. L. W. Shakespear. Pp. xvii+272. (London: Macmillan and Co., Ltd.) 10*s.* net.

Transpiration and the Ascent of Sap in Plants. By Prof. H. H. Dixon. Pp viii+216. (London: Macmillan and Co., Ltd.) 5*s.* net.

The Mirror of Perception. By L. Hall. Pp. 129. (London: Love and Malcomson, Ltd.) 2*s.* 6*d.*

British Museum (Natural History). British Antarctic (*Terra Nova*) Expeditions, 1910. Natural History Report. Geology. Vol. i. No. 1: Antarctic Fossil Plants. By Prof. A. C. Seward. Pp. 49+viii Plates. (London: British Museum (Natural History); Longmans and Co.) 6*s*.

The Botany of Iceland. Edited by Drs. L. K. Rosenvinge and E. Warming. Part I. 2. An Account of the Physical Geography of Iceland, with special reference to Plant Life. By Prof. T. Thoroddsen. Pp. 191—343. (Copenhagen: J. Frimodt; London: J. Wheldon and Co.)

A Text-Book of Inorganic Chemistry. Edited by Dr. J. N. Friend. Vol. i., Part i.: an Introduction to Modern Inorganic Chemistry. By Dr. J. N. Friend, H. F. V. Little, and Dr. W. E. S. Turner; Part 2: The Inert Gases. By H. V. A. Briscoe. Pp. xv+385. (London: C. Griffin and Co., Ltd.) 10*s*. 6*d*. net.

A Theory of Time and Space. By A. A. Robb. Pp. vi+373. (Cambridge University Press.) 10*s*. 6*d*. net.

The House-Fly, *Musca domestica*, Linn. By Dr. C. G. Hewitt. Pp. xv+382. (Cambridge University Press.) 15*s*. net.

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1913. Pp. 110. (Bath: *Herald* Press.)

Elements of Geometry. By S. Barnard and J. M. Child. Parts i.–vi. Pp. ix+465+xxxviii+Answers. (London: Macmillan and Co., Ltd.) 4*s*. 6*d*.

The Principles of Irrigation Practice. By Dr. J. A. Widtsoe. Pp. xxvi+496. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

Japan To-day and To-morrow. By H. W. Mabie. Pp. ix+291. (London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

Feeble-Mindedness: its Causes and Consequences. By Dr. H. H. Goddard. Pp. xii+599. (London: Macmillan and Co., Ltd.) 17*s*. net.

Lektrick Lighting Connections, with Introductory and Explanatory Notes. By W. P. Maycock. Third edition. Pp. 133. (London: Lundberg and Sons.) 6*d*. net.

Transactions and Proceedings of the New Zealand Institute for the Year 1913. Vol. xlvi. June, 1914. Pp. vii+436. (Wellington, N.Z.: J. Mackay; London: W. Wesley and Son.)

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 26.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Power Plant Testing: W. M. Selvey.

FRIDAY, NOVEMBER 27.

PHYSICAL SOCIETY, at 5.—Note on the Conduction of Electricity at Point Contacts: A. F. Hallimond.—Thermal Conductivity of Badly Conducting Solids: T. Barratt.

SATURDAY. NOVEMBER 28.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—Illustrations of Mycetozoa, dedicated to Samuel Dale, M.D., in Mecheli's "Nova Plantarum Genera," 1729: Miss G. Lister.—Note on Leaf-rolling Caterpillars: E. Linder.

MONDAY, NOVEMBER 30.

ROYAL SOCIETY OF ARTS, at 8.—The History and Practice of the Art of Printing: R. A. Peddie.

ARISTOTELIAN SOCIETY, at 8.—Inaugural Address: Science and Philosophy: Dr. B. Bosanquet.

INSTITUTE OF ACTUARIES, at 5.—Inaugural Address by the President, Mr. E. Woods.

TUESDAY, DECEMBER 1.

ILLUMINATING ENGINEERING SOCIETY at 8.—Illuminating Engineering in War Time: Some Lessons to be Learned from the Present Lighting of London: Dr. Leon Gaster.

WEDNESDAY, DECEMBER 2.

ROYAL SOCIETY OF ARTS at 8.—Britain and Germany in Relation to the Chemical Trade: Dr. W. R. Ormandy.

ENTOMOLOGICAL SOCIETY, at 8.—The Structure of the Scent-organs of Certain Butterflies: Dr. H. Eltringham.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Application of Spectography to Analysis: Dr. S. J. Lewis.—Note on Some Oleaginous Seeds: E. R. Bolton and E. M. Jesson.—Corrections in Bomb Calorimetry: G. N. Huntly.—Note on the Determination of Sulphates in Flour: G. D. Elsdon.

GEOLOGICAL SOCIETY, at 8.—The Shippea Hill Man: Prof. T. McKenny Hughes.—A Bone Implement from Piltdown (Sussex): C. Dawson and Dr. A. Smith Woodward.

THURSDAY, DECEMBER 3.

ROYAL SOCIETY, at 4.30.—*Probable Paper*: The Thermophone: A New Form of Telephone: M. de Lange.

CHILD STUDY SOCIETY, at 7.30.—Self Expression through Language with Older Children: Margaret Corner.

FRIDAY, DECEMBER 4.

GEOLOGISTS' ASSOCIATION, at 8.

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THURSDAY, DECEMBER 3, 1914.

DANTE'S ASTRONOMY.

Dante and the Early Astronomers. By M. A. Orr (Mrs. John Evershed). Pp. xv+507. (London: Gall and Inglis, n.d.) Price 15*s.* net.

DANTE'S cosmological ideas and his exposition of medieval astronomical knowledge have been discussed by several of the numerous commentators of his writings. It is, however, useful to have them collected in one place and discussed by a writer having a sound knowledge of modern astronomy. Mrs. Evershed has therefore done good and valuable work by producing the present volume. After a rapid sketch of the principal celestial phenomena visible to the naked eye without instruments, she gives a popular account of the progress of Greek astronomy. The "list of principal authorities" at the beginning of the book shows that this account is mainly founded on some of the principal modern books and monographs on this subject. There are very few ancient writers in the list, *e.g.* Hipparchus, Ptolemy, Seneca, and others are conspicuous by their absence. On the other hand, Cicero, "De Senectute" is included, though there is not a word about astronomy in this little book except an allusion to Gallus, who was fond of predicting eclipses.

On the whole, the account of Greek astronomy is correct, but it would have been a help to readers who may desire further information if references to the sources employed had been given in each chapter; for instance, on p. 299 (note) the authority is no doubt Smyth's "Cycle of Celestial Objects," vol. ii., p. 332, which should have been quoted. Want of knowledge of the original writers occasionally leads the author astray, as, for instance, when she gives a picture of the great equatorial at Peking, and seems to think that this was a copy of one of Ptolemy's instruments. There is no mention of equatorials in the Almagest, and it is not even certain that the Arabs constructed them, though it is probable enough, since the idea of the Peking instrument appears to be due to a Persian, Gemal-ed-din. On p. 122 it is said that Hipparchus gives a list of sixteen time-stars culminating at intervals of an hour exactly, and that his knowledge of spherical trigonometry enabled him to calculate the time of night to within one minute. But there were forty-four of these stars, and their use did not involve any calculation, as they only served to regulate the water-clocks.

Passing to the Middle Ages, the importance of astrology in those days is duly pointed out. But it is not correct to call the art of predicting the fate of an individual "judicial astronomy," as the author persists in doing. It was called "judicial astrology," not to distinguish it from the science of stellar motions, but to show that it was a special branch of the more exalted, philosophical astrology, which sprang from the loftiest views of Greek thinkers about the unity of the Kosmos and the inter-dependence of all parts thereof. The astronomical work done by the Arabs is briefly mentioned, and it is justly emphasised that Dante owed his knowledge of Alexandrian astronomy solely to the text-book of Alfraganus (Al Fargani), which he had thoroughly mastered, so that we have in the "Divine Comedy" and the "Convito" an excellent picture of the state of science at the beginning of the fourteenth century. It is only very rarely that Dante gives any astronomical information not to be found in Alfraganus, one of the principal cases being the statement that the length of the tropical year is 1/100th of a day less than 365¼ days. The author says it would be interesting to know where Dante found this value. We think there can be little doubt that he got it from the "Computus Maior" of Johannes Campanus, a Canon of Paris, in the thirteenth century, which is extremely likely to have been known to Dante's teacher, Brunetto Latini, who lived some years in France, though he does not mention the small amount of 1/100th day in his "Trésor," where he gives only round numbers.

After giving a classified list of the allusions to sun, moon, planets, and stars in the "Divine Comedy," the author discusses the time-indications given through references to the positions of the heavenly bodies in the course of the poet's journey. They show that Hell, a conical cavity reaching to the earth's centre, was entered in the evening and left twenty-four hours later, while the ascent to the other side of the earth took nearly as long. Purgatory is a conical mount on an island in the midst of the watery hemisphere at the antipodes of Jerusalem. The time spent on it brings us to the morning of the seventh day, and the ascent through the seven spheres of the planets, the sphere of the Fixed Stars, and that of the Primum Mobile to the Empyrean took eighteen hours. As regards the assumed date of the journey, it has generally been supposed that this was the spring of the year 1300, to which the historical allusions decidedly point. But in 1897 Sig. Angelitti, of the Naples Observatory, published a paper in which he showed that the positions of the moon, Venus, and Saturn given in the poem agree wonderfully well with their actual places at the end of March, 1301. The greatest difficulty to those who accept the year 1300 has always been that Venus in March of that year was invisible, while she ought to be a morning star in Pisces, which she was twelve months later. But it was pointed out six years ago that Dante very likely took the position of Venus from a perpetual Almanac compiled by a Jew. In the Hebrew original all the cycles begin in 1301, while in the Latin translations they begin in 1300, except those of Venus and the sun, which begin with 1301. It is therefore quite possible that Dante took the places of Venus for 1301, believing them to be for 1300, and Angelitti's tempting theory must therefore be abandoned, to the regret of the author of the present work, in which we cordially join.

J. L. E. D.

FOUNDATIONS OF SYSTEMATIC BIOLOGY.

Abstammungslehre—Systematik—Paläontologie—Biogeographie. Unter Redaktion von R. Hertwig und R. v. Wettstein. Pp. ix+620. (Leipzig and Berlin: B. G. Teubner, 1914.) Price 12 marks.

"TO no nation, except the German," says General von Bernhardi, "has it been given to enjoy in its inner self that which is given to mankind as a whole. We often see in other nations a greater intensity of specialised ability, but never the same capacity for generalisation and absorption." That is the German way of expressing the German capacity for organisation and compilation, which, when it produces works such as that of which the present volume is a portion, performs a valuable service to the intellectual world. The whole work, "Die Kultur der Gegenwart," purports to be a systematic survey of modern culture on a historical basis, portraying the fundamental achievements of the diverse centres of civilisation in their relation to the whole as it exists now or promises to be developed hereafter. The division allotted to the organic natural sciences comprises four volumes, of which this is logically the last. Volume ii., the only other as yet issued, was reviewed by us in April, 1914 (vol. xciii., p. 107).

In view of the claim mentioned above, it is interesting to note that the contributors are not all German, for besides R. Hertwig, L. Plate, A. Brauer, A. Engler, and K. Heider, there are the Austrians, R. v. Wettstein and O. Abel, the Dutchman, W. J. Jongmans, and the Dane, J. E. V. Boas. It is, moreover, pleasing to observe that these authorities do not neglect the workers in other countries, but, by the lists of leading books which they furnish, prove that in this department, at all events, all nations take their share, and that the fellow-countrymen of Darwin have no reason to feel ashamed. The truth is that, though in art there must be nationality, science has become absolutely international: the observation made by a Dane to-day is checked by a Japanese to-morrow, and an American then carries it a step further.

It would not be possible, even in several pages, to give a critical summary of what is itself a summary, and an admirably critical one, of the whole world's work in that which, from a theoretical point of view, is the most important branch of biology. Few men could have written a more lucid, a more just, or a more thought-compelling account of the doctrine of descent than Prof. Richard Hertwig. "It is," he concludes, "the only possible theory . . . and the one that has given the weightiest impulse to this science. The crowd of exact investigations that has resulted from Darwin's writings may seem to have gone beyond or even away from him; but these last years show an unmistakable return to the views of the great British naturalist."

The articles on geographical distribution by Profs. Brauer and Engler, on palæontology by Profs. Abel and Jongmans, on the classification and phylogeny of plants by Prof. von Wettstein, and on the phylogenies of invertebrate and vertebrate animals by Profs. Heider and Boas, may be open to criticism in details, but afford on the whole admirable digests, made interesting by the fact that the distinguished authors have taken their own lines on disputed questions. It is, however, the chapter by Prof. L. Plate on the principles of taxonomy with special reference to the classification of animals that fills the most urgently felt want. The mere description of new species, as carried out by too many writers, is far from being good systematic work, or even scientific work at all. But the true systematist has perpetually to exercise his mind with the most complicated problems of his science, cannot venture to eschew metaphysics, and has even to rival the poet in his use of the imagination. All systematists who would understand their own task should read Dr. Plate's illuminating review of modern methods and ideas. F. A. B.

SCIENCE, METAPHYSICS, AND EDUCATION.

(1) *The Anthropology of the Greeks.* By E. E. Sikes. Pp. xii+112. (London: David Nutt, 1914.) Price 5*s.* net.

(2) *The Mechanistic Principle and the Non-mechanical.* By Paul Carus. Pp. 125. (Chicago and London: The Open Court Publishing Company. 1913.) Price 4*s.* net.

(3) *Transformisme et Créationisme.* By Prof.

J. L. de Lanessan. Pp. 352. (Paris: Librairie Felix Alcan, 1914.) Price 6 francs.

(4) *A History of Education in Modern Times.* By Prof. F. P. Graves. Pp. xv+410. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 5*s.* net.

(5) *Methodik und Technik des naturgeschichtlichen Unterrichts.* By Prof. W. Schoenichen. Pp. xiv+611+30 plates. (Leipzig: Quelle and Meyer, 1914.) Price 12 marks.

(1) THERE is always an interest, and often no little instruction, to be derived from a study of the science and religion of ancient civilisations, especially when considered in their inter-relations. One of the newest of sciences, anthropology, appears to be rooted in the earliest strata of thought, as, for instance, among the natives of Central Australia. Greek speculation upon the origin and development of mankind was not limited to fairy-tales of the Golden Age type. From Herodotus onward their best minds had a very shrewd idea of the real process, such as we have come to see it. Lucretius repeated, with original observations of his own, the anthropological theories of Epicurus. But these are the culmination of Greek scientific thought in this direction. They were foreshadowed by Aeschylus and Herodotus, and developed later. It seems that the Greeks, who certainly had considerable opportunities, thanks to their trade, travel, and warfare, collected a considerable body of data relating to savage and barbarous peoples in the west, the east, and the south. There was, of course, another school, the Platonic; it was true then, as ever since, that a man is born either an Aristotelian or a Platonist. Then, too, as now, the Platonist built upon teleology. Mr. Sikes has done well to collect every statement in Greek literature that throws light on the scientific ideas of that "most quick-witted and curious of human races," concerning the origin and development of their own species. It should be read by all anthropologists, whether their Greek is "less" or more.

(2) But the Greek mind was more interested in the problems of cosmic and ultimate metaphysics, and the issues waged between Determinists and Creationists, or, whatever the two fundamental types of mind be termed. These issues seem destined to be eternal. So Dr. Paul Carus, following up his interesting propaganda of many years, writes some notes upon representative quotations from exponents of both sides. "Mechanicalism" and teleology are first contrasted. The "contributions," as they may be called, to his volume include some very interesting expressions of opinion, especially Mark Twain's philosophy and La Mettrie's famous exposition of man "as a machine." It is curious that La Mettrie, when persecuted for his opinions, found refuge in Prussia and received a pension from Frederick the Great.

In another chapter Prof. W. B. Smith's eloquent article from the *Monist* works up to the conclusion that "it is a false antagonism between the causative and the teleological conceptions of the universe." Dr. Carus's text is that "nothing moves, nothing stirs nor happens that does not act in agreement with the laws of motion, and there is no harm in it that man's activity takes place in perfect agreement with mechanical laws. A man's a man for a' that!" As for the ancient and modern puzzle—dualism or monism—he says, using Ezekiel's metaphor, "There are not two things, the spirit and the wheels, but there is one reality." "Both spirit and machine are one, and the universal dominance of the laws of form determining the detailed uniformities of motion, commonly called mechanics, is by no means a depressing or melancholy thought. The laws of form are the very means in which spirit reveals itself."

(3) That versatile writer, Prof. de Lanessan, has written a critical history of the relations between these two modes of thought. He considers that evolutionary determinism (*transformisme*) and animistic supernaturalism (*créationisme*) are ultimately the only possible theories of the universe. He traces their elements back to the priestly caste of Mesopotamian culture, and carries his account up to Darwin. Considerable space is rightly given to de Buffon, the teacher of Lamarck. Except in the most recent times, the great majority of determinist thinkers have fallen back upon animism to explain the ultimate origin of the universe, or the presence in it of mind. Prof. de Lanessan promises a second volume, dealing with the developments subsequent to Darwin.

(4) If objective science be described as the obverse of human mentality, education is its reverse. From another point of view, as old as the Greeks, education and socialisation—"politics" in the Greek sense—are complementary. Prof. Graves has written the history of education before the Middle Ages, and from that period to the eighteenth century. He now completes his survey by a volume describing the progress of educational theory and practice, the latter in particular, from the eighteenth century (inclusive) up to the present day.

It is curious to reflect that the "classical" education, still the pabulum of English upper-class youth, was denounced more than a century ago by the French reformer, Rousseau. Equally interesting is the fact that practically all subsequent educational reformers have been the intellectual heirs of the French iconoclast, such as Pestalozzi, Fellenberg, Froebel, Herbart, and Montessori. While giving prominence to the evolution of education in America, Prof. Graves does not neglect this or other countries, and his account of the German experiments at Neuhof, Königsberg, and Keilhan is detailed. He has an interesting chapter on the introduction in recent years of scientific subjects into curricula, and another on the application of psychological results to the methods of education. The book includes an excellent selected bibliography, very useful in view of the enormous literature of the subject.

(5) The series of scientific and mathematical handbooks edited by Dr. Norrenberg is an encyclopædia for teachers. The fifth volume, on methods of instruction in natural history, by Prof. Schoenichen, of Posen, contains more than six hundred pages, crammed with detailed advice and facts. The author attempts, with success, to cover the whole ground of zoology, botany, and biology generally as an educational subject, and from the teacher's point of view. From psychological pedagogy to gardens and vivaria, he omits nothing that can come into the ken of the schoolmaster. Courses are laid down for the various classes in the Gymnasium, the Real-gymnasium, and the Real and Oberrealschule. The suggestions about methods of drawing, and those on excursions and collecting are excellent. A notable feature is the description of models, their manufacture and use.

Fas est et ab hoste doceri; the book is a triumph of method. A. E. CRAWLEY.

OUR BOOKSHELF.

The Rubber Industry in Brazil and the Orient. By C. E. Akers. Pp. xv + 320. (London: Methuen and Co., Ltd., 1914.) 6*s.* net.

MR. AKERS contrasts in this book the unscientific, and unbusinesslike, rubber-collecting industry of Brazil with the rubber-planting enterprises of the British and Dutch East Indies, which are conducted on more or less scientific lines and with the commercial skill and acumen which distinguishes the two peoples concerned with these East Indian Colonies.

Compared with their competitors in the East, the rubber producers in Brazil have one great advantage—their trees are mature and in their natural habitat. This advantage is believed to account for the general opinion that Brazilian Para rubber is better than the plantation article from the East Indies. Many competent judges maintain that this advantage is illusory, and that properly-prepared East Indian plantation rubber, from well-established trees of fair age, is just as good as "fine hard Para," and that the premium obtained by the latter in the markets is the result of conservative prejudice on the part of manufacturers. However that may be, the advantage, supposing it is real, is bound to disappear, in view of the increasing age of the plantations in Ceylon and Malaya, and the untiring efforts of the planters there to improve and unify their methods of preparation.

In all other respects, such as cost and efficiency of labour, good administration and government, business skill and foresight, and last, but not least, the realisation of the necessity for scientific and technical research, the advantages lie with the East Indian producers, and Mr. Akers makes it clear that unless there is a drastic change in the conditions of working in Brazil, the rubber industry there is bound to disappear in the face of the competition of the East Indian plantations.

Mr. Akers probably records little that is new to rubber planters, but his book is none the less interesting on that account, and it can be cordially recommended to all who are interested in the development of this great industry, in which British enterprise and technical skill have played so large a part.

The Beginner's Garden Book: a Text-book for the Upper Grammar Grades. By A. French. Pp. viii + 402. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1914.) Price 4*s.* 6*d.* net.

THERE is always much to learn from an American teacher of a rural subject. The science may be superficial, yet he manages to get his students to think about their work and to find reasons for the way in which the work is done. This book is a case in point. It takes the form of an address by a teacher of school gardening to boys engaged in the cultivation of school gardens. The American origin of the book little interferes with its use in this country. The English is almost free from Americanisms, and the cultivation of all our more commonly grown vegetables and flowers is described. The treatment of fruit culture and bastard trenching is inadequate, and grafting and budding are not even mentioned, but, on the other hand, several matters are dealt with that do not often find a place in gardening manuals. The chapters on the saving of seed and on gardening under glass are excellent. A good deal of gardening can be learnt by merely looking at the numerous illustrations.

An Introduction to Geology. By C. I. Gardiner. Pp. xiv + 186. (London: G. Bell and Sons, Ltd., 1914.) Price 2*s.* 6*d.*

MR. GARDINER is well known as a field-observer, and has added largely, both by himself and with Prof. S. H. Reynolds, to our knowledge of Silurian areas. He now attracts others to his favourite studies by a clearly written introduction to geology, which will be of especial interest to dwellers in the English midlands. General principles are supported by more detail than is usual in elementary works, and this method carries conviction as to the reality of the facts described. For instance, both a map and a photograph are given of Churchdown, the conspicuous outlier that rises above the Lias plain near Gloucester; while the description of the successive layers in the Victoria Cave furnishes an impressive picture of the history of British man. The statement of the loss of land along the Yorkshire coast demonstrates the effectiveness of forces now in action, and two successive views are given of the destruction of a chalk headland near Swanage.

The illustrations are practically all new, including a fine view into Lulworth Cove, taken from the hill at its west end. The printers have twice gone astray on the difficulties of Rhynchonella (pp. 60 and 79), and a bracket needs extension on p. xi to include the Cainozoic systems; but the mode of production shows how generously publishers are prepared to meet the demand for readable works on nature-study. G. A. J. C.

Catalogue of the Ungulate Mammals in the British Museum (Natural History). Vol. iii. Artiodactyla, Families Bovidæ, Subfamilies Æpycerotinæ to Tragelaphinæ (Pala, Siaga, Gazelles, Oryx Group, Bushbucks, Kudus, Elands, etc.), Antilocapridæ (Prongbuck), and Giraffidæ (Giraffes and Okapi). By R. Lydekker, assisted by G. Blaine. Pp. xv + 283. (London: British Museum (Natural History), 1914.) Price 7s. 6d.

THE third volume of the British Museum catalogue of Ungulates completes the account of the antelopes (saiga, gazelles, oryx group, bushbucks, kudus, elands, etc.) and deals also with prongbucks and giraffes. Like its predecessors it is a fine piece of work with terse descriptions and scholarly synonymy. Its usefulness has been notably increased by the inclusion of fifty excellent figures, mostly of heads. As a work of reference it will be of great value and interest to those who have collected trophies of this sort. The prongbuck, the position of which has been the subject of discussion, is ranked by Mr. Lydekker as the only living representative of a separate family, Antilocapridæ. Another interesting type, the Okapi, represents a genus along with the giraffe in the family Giraffidæ. Among the many other interesting forms may be mentioned, Ammodorcas, Æpyceros (the Pala), the Saiga, and the Chiru.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Age of a Herring.

To my doubts as to the truth of Dr. Hjort's theories of the herring's age, Dr. Hjort and Mr. Einar Lea have now replied (NATURE, November 5) by recapitulating their main arguments. I can do little more than reiterate my own unaltered incredulity. My position is simply this, that a theory has been put forward which seems to me, *a priori*, extremely improbable, and that the statistical data on which it is based are, to my mind, not strong enough to support it. The large assertion that the Norwegian spring herring have consisted, in preponderating or overwhelming proportion, year by year from 1908 to 1913, of fish spawned in 1904, is based (so far as I can discover) on only nineteen samples, or little more than two a year, averaging somewhat above 300 herring each. Dr. Hjort and Mr. Lea have no difficulty in showing that their 1913 herring, grouped according to scale-rings or alleged years of growth, form a curve which is a bad fit to a probability curve; but they do not remind us that this so-called sample is no sample at all, but is a conglomeration of three separate samples from far-distant localities. Dr. Hjort's full data have not been published, so far as I know, for the years since 1909; let us try to discover how, for the year 1908, he arrives at the figure 34·8, which he gives (*cf.* NATURE, August 27, p. 672) as the percentage proportion, in the entire stock of Norwegian spring herring, of fish spawned (according to the evidence of their scale-rings) in 1904. I find that this determination was based on two samples only,[1] from different localities, one consisting of 881 fish, the other of 549. In the former sample the percentage of 1904 fish is given as 15·9, in the latter as 65·2. The former determination, by Mr. K. Dahl, seems a little shaky: for an independent determination of a part of the same sample, by Mr. Einar Lea,[2] gave the alternative value of 10·2. But be that as it may, I find that Dr. Hjort's result is obtained by the simple method of adding together the two samples, one of 881 fish showing 15·9 per cent., the other of 549 fish showing 65·2 per cent., and so the resulting mean value of 34·8 per cent., decimal and all, is straightway arrived at. It does not need the eye of a mathematician to see that, in a problem of biological statistics, such a method of calculation is inadequate; and that it neither proves nor even renders probable the conclusion drawn from it, namely, that four-ringed herring (whatever those four rings may mean) constituted 34·8 per cent. of all the spring herring in Norway, in the year in question.

D'ARCY W. THOMPSON.

The Cross X as a Symbol for Multiplication.

HISTORIANS of mathematics attribute the first use of the cross × as a symbol for multiplication to William Oughtred ("Clavis Mathematicae," London, 1631). See W. W. R. Ball's "Short Account of the History of Mathematics," fifth edition, 1912, p. 239; M. Cantor's "Geschichte der Mathematik," Bd. ii., 1892, p. 658; J. Tropfke's "Geschichte der Elementar Mathematik," Bd. i., 1902, p. 135. In some places, as, for instance, in Oughtred's "Circles of Proportion" (London, 1632, p. 38), the two bars of the cross are not quite straight, giving the symbol the appearance of the small letter *x*. In some of John Wallis's writings, as, for example, his "Elenchus geometriae Hobbianae," etc. (Oxford, 1655, p. 23), the symbol is not the usual cross, but is plainly the capital letter ⋉ turned on its side. In a paper by Lord Viscount Brouncker in the Philosophical Transactions (vol. ii., 1668, p. 646), the capital letter X occurs regularly as the symbol for multiplication. These and similar cases lead to the inference that the cross and the letter *x* were considered practically one and the same symbol for multiplication.

In this connection we desire to point out that the small letter *x*, and also the capital letter X, occur as symbols for multiplication before Oughtred (1631) in

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[1] Hjort, "Rapports et Procès-Verbaux, vol. xx., p. 29. (Copenhagen, 1914.)

[2] "Public. de Circonstance," No. 53, p. 94. (1910.)

Edward Wright's translation of John Napier's "Mirifici logarithmorum canonis descriptio," brought out in its second edition at London in 1618, where we read p. (4): "The note of Addition is (+) of subtracting (−) of multiplying (*x*)." This is taken from a part of the book under the heading, "An Appendix to the Logarithmes," the authorship of which is not given, but is probably to be attributed to Samuel Wright, who is reported to have been the editor of the book. Accordingly, the symbol × occurring in Oughtred is probably a modification of the letter *x* that was first introduced at least thirteen years earlier, and probably by Samuel Wright. FLORIAN CAJORI.

Cambridge, November 25, 1914.

ANTARCTIC ADVENTURE.[1]

THIS full account of the life and work of Scott's northern party is a welcome addition to the longer story of their work by Commander Victor Campbell in "Scott's Last Expedition." It was originally intended by Captain Scott that this party, of six men all told, should make their base on King Edward Land. When ice conditions prevented this they searched in vain along the coast of Victoria Land for a suitable landing until they had no alternative but to make use of Cape Adare, Borchgrevink's old winter quarters. Commander Campbell was well aware of the drawbacks to this place, from which it is impossible to sledge overland in any direction, but he had no choice in the matter. Either the party must land there or return to New Zealand in the *Terra Nova*. The winter at Cape Adare was spent in comparative comfort and the account reads like that of any other antarctic winter under modern conditions of equipment. A well-equipped party, in good health, need suffer no particular inconvenience nowadays in a polar winter. Sledging in spring along the sea-ice to the north proved impracticable, and in this respect Commander Campbell and his men had the same experience that almost all explorers have had in the south. No travelling can be more precarious than that over sea-ice in the vicinity of open water.

But it is the story of the second year's adventures which is the most interesting part of this book, for it was then that the author and his companions went through an almost unique experience. The only comparable story in the annals of the south pole is the wintering of Gunnar Andersson and two companions of Nordenskjöld's Swedish Antarctic Expedition in 1903 in a stone hut at Hope Bay, Louis Philippe Land.

The *Terra Nova* had picked up the six men at Cape Adare early in January and landed them four days later at Evans' Coves, about 270 miles to the south. From there they were to be taken by the ship on her return to New Zealand in March. The *Terra Nova* failed in three attempts to reach them, and so they were left to their own resources. But we cannot understand why these six men were landed with only six weeks' sledging provisions, and skeleton rations for another four weeks. Nor does Mr. Priestley's account make this arrangement clearer to us. He admits, in fact, that Commanders Pennell and Campbell had agreed that if the shore party were not picked up by March 18 they were to resign themselves to spend another winter as best they might. At the time, no doubt, they both thought this eventuality a remote one: "we would all have sworn that if there was one place along the coast which would be accessible in February, this would be the one." But it was a risk that should never be taken in polar exploration if it can possibly be avoided.

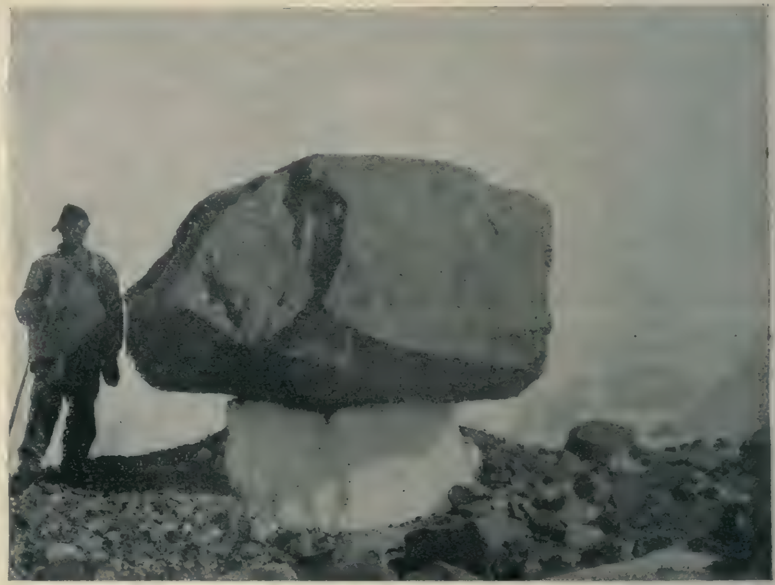

FIG. 1.—A glacier table. From "Antarctic Adventure."

The party spent the winter in a snow cave hollowed out of a drift, eking out their scanty rations with seal meat. They had a hungry winter, but appear to have been cheerful and in comparatively good health throughout. Commander Campbell and his comrades deserve congratulations for this achievement. In October they sledged southward along the coast to the main base of the expedition at Cape Evans. Doubtless this journey was impractical in winter, but we would have liked to read the reasons which decided Commander Campbell to winter under these difficult, not to say precarious, conditions, at Evans' Coves rather than attempt the retreat to Cape Evans, some 250 miles, in late autumn. It is not on account of new discoveries and scientific work accomplished that this volume is important, for of new discoveries the northern party had few, and very seldom does Mr. Priestley reveal the result of their scientific work during the first winter: during the second, of course, little could be accomplished. But the interest of the volume lies in its being a full account of how six men lived through an antarctic winter practically on what land and sea produce, and so proved that this can be done with comparative safety. That is the importance of Mr. Priestley's book, and as such, it should be studied carefully by every future explorer in polar regions. The author has been careful to record every expedient and makeshift he and his comrades found useful in their long struggle against adverse circumstances, and it is all these trifling details that give great value to the book. The work is well illustrated and contains three maps.

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[1] "Antarctic Adventure. Scott's Northern Party." By R. E. Priestley. Pp. 382 + maps and illustrations. (London: T. Fisher Unwin, 1914.) Price 15*s*. net.

R. N. R. B.

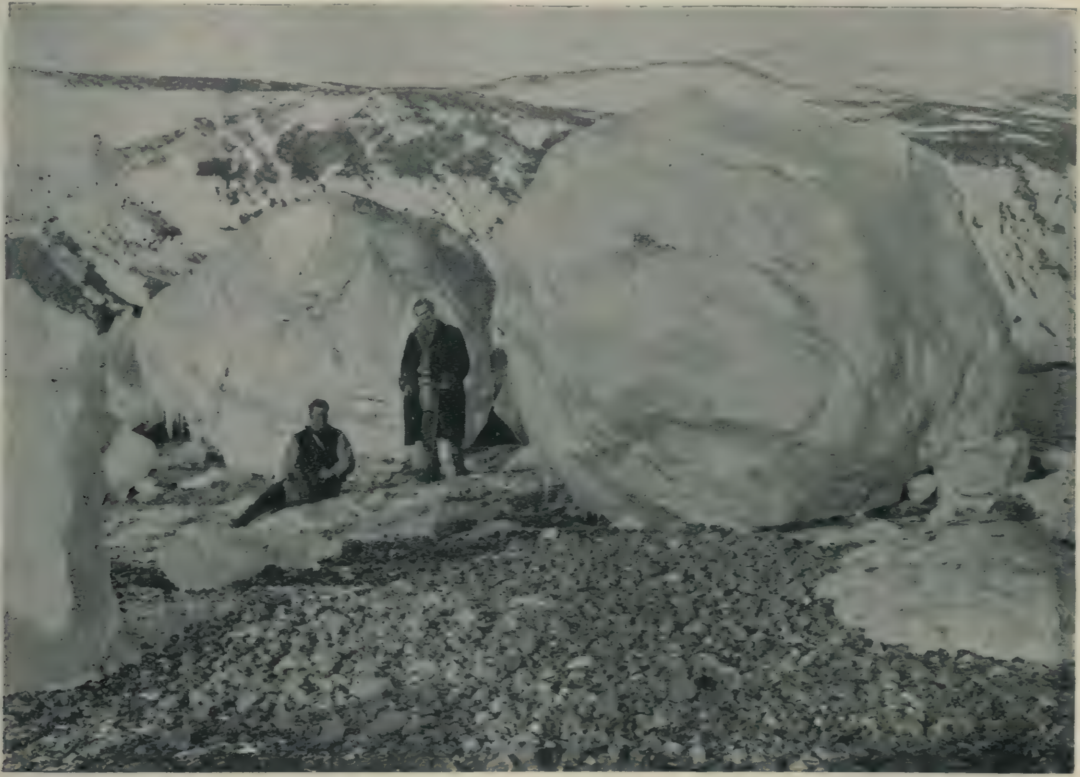

Fig. 2.—Ice boulders hurled up the beach by a heavy swell. From "Antarctic Adventure."

SECRET REMEDIES.

It will scarcely be questioned that the freedom allowed to quackery in this country is unreasonable. To estimate properly the effect of drugs on the progress of disease in the human body is one of the most difficult of tasks, even for highly trained observers; yet any person vending alleged remedies is permitted to assert the efficacy of his nostrums in the cure of ailments, and to use the public as *corpus vile* for them, practically without let or hindrance. Not only so; he often mulcts the public heavily for the privilege.

This is the conclusion forced upon the reader by a perusal of the Report of the Select Committee appointed to inquire into the question of the sale of patent and proprietary medicines. The anomalies and curiosities of the law and practice concerning these commodities are, the Committee finds, "numerous and remarkable," but as they are not specially pertinent to these columns, the interested reader is referred to the Report itself for examples.

The medicines in question differ widely in character. "At one end of the scale is the valuable scientific preparation; at the other is the mere vulgar swindle." They are classified by the Committee as follows:—

Class A: Non-Secret.—(1) Proprietary preparations consisting of genuine drugs, synthesised or extracted by skilled chemists and tested by therapeutists. Examples are aspirin, adrenaline, and urotropine. (2) Remedies which owe their value to skilful combination, such as mixtures of bismuth salts with pepsine. (3) Known drugs, with the formula disclosed, but mixed for convenience with inert substances the nature of which is a trade secret—*e.g.*, "tabloids."

It is considered that, with some possible exceptions, there is nothing in this class which calls for interference in the public interest.

Class B: Secret.—(1) Simple household remedies, often originally manufactured from a doctor's family prescription, and undoubtedly beneficial for uncomplicated ailments. The chief criticism made upon the sale of medicines belonging to this group is that their retail price is out of all proportion to their cost, and that they are often recommended for cases they cannot benefit, thus causing the purchaser to run risk of serious injury by delay in seeking proper medical treatment. (2) Dangerous remedies which should not be sold at all, or only on a doctor's prescription; or which should not be sold for the purpose for which they are offered. (3) Fraudulent remedies: these are a large group, consisting of abortifacients, alleged cures for cancer, consumption, diabetes, paralysis, epilepsy, deafness, and so on, together with electric belts, apparatus for supplying oxygen to the system (otherwise than by respiration), "ionised" water, and the like. With a touch of humour, the Committee remarks that "the discovery of radium will probably add a number of remedies to this group." It has, in fact, already added some. The treatment of "remedies" included in this category need involve no doubt or hesitation. "They are, and are known by their makers to be, cruel frauds." The sale and advertisement of them should be prohibited under drastic penalties. Finally, (4) there is a large group of remedies making grossly exaggerated claims. In respect of these, it is regarded as beyond doubt that the public is defrauded on a large scale by promises which cannot be fulfilled.

A good deal was said during the inquiry about the difficulty, and even the impossibility, of completely analysing certain medicines—a matter which is vital to many proposals for dealing with secret remedies by law. It was pointed out that even such familiar and apparently simple articles as extracts of dandelion and gentian are really highly complex bodies, the exact composition of which is still unknown to chemistry, and when several such extracts are present in a mixture detection of all becomes difficult, and accurate determination of any may be out of the question. But whilst this is true enough, the focussing of the discussion upon this point puts the matter out of perspective. There are limits to the powers of analysis, but in a large majority of cases the essential nature of the principal constituents of any medicine can be detected with almost perfect certainty and determined with reasonable accuracy, given skill, time, and a sufficient quantity of material.

Several abuses in connection with secret remedies are indicated. Thus the composition has sometimes been changed whilst the name remained unaltered; *e.g.*, acetanilide has been replaced by phenacetin, and the potent drug morphine has been added in one case, removed in another, without the change being brought to the purchaser's notice. Again, one medicine is recommended as "a safe and simple remedy" for both asthma and bronchial affections, though these are medically of quite different types, the former being a nervous disease, the latter an inflammation of the mucous membrane.

The Committee gives cogent reasons against adopting a suggestion made by medical witnesses and others, namely that every remedy sold should be compelled to bear a label stating its exact composition. This would inflict hardship; it would not necessarily convey useful information to the purchaser, who could not be expected to know chemical names such as, for example, "hexamethylene-tetramine"; moreover, an accurate statement might be in itself misleading. It is proposed, however, that an exact and complete statement of the ingredients and their proportions should be lodged with a department of the Government, and controlled by a confidential analysis. All patent, secret, and proprietary remedies should be registered with this department, and a special Court or Commission should have power to prohibit the sale or advertisement of such remedies, either in the public interest or on the ground of non-compliance with the law. New legislation is urgently needed to deal with a state of things which has become intolerable.

The findings and recommendations of the Committee are too lengthy to summarise further here. It may be said generally that the Report is fair but firm, and shows that its compilers, whilst considering legitimate interests, have not allowed themselves to be hoodwinked by the quack.

ORGANISATION OF SCIENCE.

JUST before the beginning of the war much fruitful discussion was going on in the columns of NATURE, the *Morning Post,* and *Science Progress* on the subject of the encouragement of science; and those who are interested in the theme should read Dr. R. S. Woodward's address on the needs of research, delivered on the occasion of the dedication of the Marine Biological Laboratory, Woods Hole, Massachusetts (*Science,* August 14, 1914).

Dr. Woodward begins by exposing some of the popular fallacies regarding research—that it "is akin to necromancy"; and that "the more remarkable results of research are produced not by the better balanced minds, but by aberrant types of mind popularly designated by that word of ghostly, if not ghastly, implications, namely, 'genius.'" He has also exposed the absurdity that research institutions should busy themselves in soliciting suggestions from the amateur public outside, that is, "in casting drag-nets in the wide world of thought, or in dredging, as biologists would say, with the expectation that out of the vast slimy miscellanies thus collected there will be found by the aid of a corps of patient examiners some precious sediments of truth." He thinks that "important advances in knowledge are far more likely to issue from the expert than from the inexpert in research."

Dr. Woodward traverses the idea "that research is a harmless and a fruitless diversion in the business of education"; and gives some figures as to the comparative expenditure of the United States on education and research respectively.

The number of higher, or degree-giving, establishments in the United States is now upwards of six hundred; the aggregate annual income of these is upwards of one hundred millions of dollars; and the number of officials connected with them is upwards of thirty thousand. On the other hand, the number of independent research organisations in the United States is less than half a dozen; their aggregate annual income is less than two million dollars; and the number of officials primarily connected with them is less than five hundred.

Something very like this holds also in Britain, and indeed throughout the world. Men cannot be made to understand, even with the astonishing results which investigation has placed before us, the supreme importance of such effort. They still conceive that it is more important to teach boys how to do things than actually to get the things done.

The war now raging will at least demonstrate one thing to humanity—that in war, at least, the scientific attitude, the careful investigation of details, the preliminary preparation, and the well thought-out procedure bring success, where the absence of these leads only to disaster. So also in everything. After all, the necessity for research is the most evident of all propositions. But the question (which I hope will receive still more careful attention when the war is over) is, What can the State do to make the machinery of investigation the most efficient possible? The mere citing of popular misconceptions is not enough; we need to have specific programmes. The October number of *Science Progress* contains one such programme, which I hope will receive the attention of men of science. Whether all the items are accepted or not remains to be seen; but until the discussion is earnestly undertaken, we can scarcely hope that the State will give more help than it has done hitherto. Dr. Woodward puts his finger upon a weak point in men of science as a body. "We are," he says, "as a class of too recent monastic descent to fit comfortably in our present social environment." That is just it. We are not strong enough in making our demands heard; and, in my opinion, this is not a virtue, but a neglect of duty.

RONALD ROSS.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held on Monday, November 30, when an address was delivered by the president, Sir William Crookes, and the report of the council was presented. After referring to the financial strain under which the society and the National Physical Laboratory have been placed by the war, the president passed to the consideration of the constitution of the atom and the work of the medallists. Subjoined are the portions of the address referring to these matters:—

The subject of the constitution of the atom has come into extreme prominence—great advances have been made—while much light has been thrown on the ultimate structure of matter. Years ago, during the persistent and systematic fractionation of yttrium, I explained that I had succeeded in separating the atoms of the so-called element into groups; these groups undoubtedly exhibited different phosphorescent spectra and presumably had different atomic weights—although from the chemical point of view all the groups behaved similarly. I concluded that, of the lines and bands of the compound spectrum of an element, some are furnished by certain atoms and some by others. I pointed out that this was not likely to be an isolated case; that probably in all so-called elements the whole spectrum does not come from all the atoms—that different spectral rays come from different atoms, which may be interpreted to mean that there are definite differences in the internal motions of the several groups of which the atoms of a chemical element consist. I ventured to suggest a possible explanation of these facts, based on the assumption that acting on the original *protyle* were two forces—one of the character of Time, accompanied by a lowering of temperature, while the other, swinging to and fro like a pendulum, and having periodic cycles of ebb and flow, rest and activity, would be intimately connected with the force of electricity. I arrived at a presentation of the elements on a lemniscate path which seemed to me to throw some light on the question of their genesis. My researches seemed to show that the persistence of the ultimate character, the eternal self-existence, the fortuitous origin of the chemical elements, could no longer be regarded merely as probable.

Apparently bodies exist which possess close upon the same atomic weights and combine in definite proportions with other substances and yet exhibit certain minute differences. For these substances, which are capable of being isolated and identified, I suggested the name "meta-elements." Thus there appears to me to be a gradation of molecules of different ranks between the atom and the compound—and these aggregations of atoms in certain circumstances might well pass for simple elementary bodies.

In recent years the old idea of the ultimate atom as a solid particle, spherical or otherwise, has slowly, almost imperceptibly, given way to the more rational conception of a minute planetary or "Saturnian" system of dazzling complexity; the conception is many-minded, aided here and there by facts that failed to fall in with the old lines of thought. Among the most prominent men through which the new conception has come to light, we have Kelvin, Stoney, Thomson, and, more recently, headed by Sir Ernest Rutherford, a host of vigorous workers in the new science of radio-activity, who have built up a conception of atomic physics often "hard to be understood," but that probably is a move in the right direction. Sir Ernest Rutherford supposes the atom to be composed of a nuclear positive charge, exceedingly small compared with the sphere of action of the atom, and consisting of a number of unit charges. Surrounding this nucleus is an external shell in which a number of separate negative electrons are distributed. Prof. Soddy—whose name is closely associated with that of Sir Ernest Rutherford—is one of the earliest workers in radio-activity, and has developed a theory of the chemistry of the radio-elements based upon the periodic law and a modified form of lemniscate spiral where the existence of *pseudo*-elements having slightly different atomic weight but identical chemical properties are set out. These "isotopic" elements occupy the same place in the periodic table. He has thus arrived, by a totally different path from the one I travelled, at the conception of an element having atoms of different weight though chemically identical. The theory has recently received some confirmation by the analyses of the lead that is found in the minerals pitchblende, thorianite, etc. In my own laboratory a spectroscopic examination of the lead from Cornwall pitchblende has shown traces of thallium not found in pure assay lead; the unexpected presence of this element may have some bearing on the slightly different atomic weight values recorded for the lead extracted from the radio-minerals.

Without risking a charge of being unduly optimistic I think I may believe we are on the brink of striking developments in our knowledge of the structure of the elusive atom. Whatever may be the outcome of researches now prosecuted with so much zeal and success, I feel that Addison was speaking with the voice of prophetic Truth when, more than a hundred years ago, he said: "Every atom is a standing miracle and endowed with such qualities as could not be impressed upon it by a Power and a Wisdom less than infinite."

Medals.

With great pleasure I announce that the Copley Medal this year is awarded to Sir Joseph John Thomson, in recognition of the value of his researches in physical science. His early work in the investigation of electrical phenomena showed he possessed a high degree of experimental ingenuity and skill: by his study of the passage of electricity through gases he elucidated the nature of the negative electrical particles, thus providing an experimental basis for the atomic theories of the nature of electricity. His treatise on the conduction of electricity through gases won for him a world-wide reputation as a physicist—to which subsequent work has added. To him is due the investigation of the nature of the positive carriers of the electric charge; his method of positive ray analysis puts a new and extraordinarily valuable tool into the hands of investigators. His experimental work has always been controlled and confirmed by theoretical considerations; his work at the Cavendish Laboratory at Cambridge has greatly extended our knowledge of the structure and nature of matter.

The two Royal Medals annually presented by the King have—with his Majesty's approval—been assigned to Prof. E. W. Brown and Prof. W. J. Sollas. Prof. E. W. Brown, who now occupies the chair of mathematics at Yale University, devoted himself for many years to the study of the movements of the moon; and by incredible industry seven years ago he brought to a successful conclusion his investigation of this fundamentally important practical problem. He has recently further studied some phenomena which known gravitation causes do not explain, and he has extended his investigations to the general theory of orbits. His work in dynamical astronomy has been remarkably fruitful, and doubtless the years to come will add lustre to his already brilliant reputation.

The Royal Medal—awarded to a worker in biological science—this year has been conferred on Prof. Sollas, who is a pioneer in many fields, and has made many valuable contributions to our knowledge of geology, mineralogy, zoology, and ethnography. His monograph on sponges is a classic on the subject. He has perfected a method of obtaining transverse sections of fossil organisms, and thus he has obtained a knowledge of the structure of certain specimens which long have been the subject of dispute. We hope that Prof. Sollas will have many opportunities of extending his investigations, which already have borne so much valuable fruit.

The recipient of the Davy Medal is Prof. W. J. Pope, who has made highly important discoveries in stereochemistry, and whose work has thrown much light upon the relation between chemical constitution and crystalline structure. In collaboration with Profs. Perkin and Wallach, Prof. Pope has published the results of many experiments dealing with the isolation and investigation of optically active compounds of nitrogen, tin, selenium, and sulphur; he explains their activity by supposing that the radicles in the active compound are tetrahedrally arranged round a central atom as in carbon compounds. With Prof. Barlow he has more recently been engaged in the establishment of a theory dealing with the connection between crystalline structure and chemical constitution. He has succeeded in reproducing the crystalline form of most substances of known composition, basing his work upon the assumptions of his theory—the experimental and theoretical results show a remarkable concordance. He has further suggested a theory of "valency volume" which is leading to important developments in the investigation of atomic volumes.

The Rumford Medal is awarded to Lord Rayleigh, in token of the council's appreciation of the mathematical and physical work associated with his name. Lord Rayleigh has, perhaps, done more than any scientific man living to stimulate research; his work in the sciences of heat and radiation has paved the way for remarkable advances, both theoretical and experimental. The Copley Medal was given to Lord Rayleigh in 1899, but the council wish to offer him some further mark of their recognition of the great value of the research which he still continues to pursue with such conspicuous success.

The Hughes Medal is this year conferred upon Prof. J. S. Townsend, of the University of Oxford, for his work upon molecular conduction in gases, and upon the nature of the disruptive discharge. Prof. Townsend has made a brilliant investigation of the phenomena of conduction by the ionisation of gases by means of Röntgen and similar radiations. The study of the diffusion of the ions of gases led to very important conclusions about the size and nature of gaseous ions—and the theory of ionisation has been greatly extended by Prof. Townsend's work.

The Darwin Medal this year is awarded to Prof. Poulton, in recognition of the value of his researches upon the curious phenomena of mimicry and protective resemblance in insects. Prof. Poulton has brought together a vast number of facts which confirm Darwin's theory on the subject, and he has recently devised and organised a remarkable series of breeding experiments with species of insects in order further to test his conclusions.

The report of the council refers, among other matters, to the effect of the war upon several undertakings with which the society is concerned. It is estimated that in connection with the International Catalogue of Scientific Literature the reduction of subscriptions and sales will mean a loss of about 4000*l.* on the three volumes in hand; and this loss will, at any rate in the first instance, fall upon the Royal Society. About forty members of the staff of the National Physical Laboratory are now serving with the colours, and this, with other results of the war, has had an adverse effect on the ordinary work of the laboratory. Should the war continue, it will be necessary to bring the question of the financial position of the laboratory before the Treasury at an early date. The donations to the society recorded in the report of the council are: 5000*l.* from Sir James Caird, in aid of physical research, the amount not to be funded, but expended as capital at the rate of about 500*l.* a year; 2000*l.* from Mr. John Dewrance, as a gift to the donation fund to secure the payment of interest amounting to 100*l.* a year, to be expended in accordance with the terms of the trust of that fund; 4000*l.* from the Misses Lawrence, the income to be devoted to research into the causes and cure of disease in man and animals, the gift being associated with the names of their father, Sir William Lawrence, F.R.S., and their brother, Sir Trevor Lawrence; 100*l.* from the late Sir Joseph Swan, in aid of the expenses of publication; 1650*l.* from the late Mr. W. Erasmus Darwin, without conditions.

On account of the war, the usual anniversary banquet was not held this year.

NOTES.

THE Academy of Natural Sciences of Philadelphia, at a special meeting held on November 24, presented the gold medal of the Hayden Memorial Geological Award to Prof. H. F. Osborn, in recognition of his brilliant palæontological studies. The presentation address was delivered by the president, the Hon. S. G. Dixon.

AT a meeting of the organising committee of the sixth International Congress of Photography, held at the rooms of the Royal Photographic Society, on Friday, November 27, it was unanimously decided to suspend the work of the committee until such time as the officers should consider it could be resumed successfully.

ON Tuesday, November 24, the Royal Geological Society of Cornwall, at its annual meeting at Penzance, presented Mr. Henry Dewey with the Bolitho gold medal for his work and papers on the survey of Devon and Cornwall. Mr. Dewey afterwards gave an account of his experiments which led him to attribute the formation of Spilosites and Adinoles to the presence of ferric or ferrous oxides in the slates into which the igneous rocks had intruded.

THE death is reported of Dr. C. S. Minot, the distinguished American anatomist, in his sixty-second year. He graduated at the Massachusetts Institute of Technology in 1872, and then spent several years in study in Europe. At Harvard University he held minor appointments from 1880 to 1888, when he became assistant professor of histology. In 1892 he became full professor, and in 1905 migrated to the James Stillman chair of comparative anatomy. Prof. Minot was a member of numerous American and foreign learned societies, and an honorary doctor of Yale, Toronto, St. Andrews, and Oxford. He was the author of "Human Embryology," "Bibliography of Vertebrate Embryology," "A Laboratory Text-book of Embryology," and "Age, Growth, and Death."

MR. JOHN BURROUGHS, of West Park, N.Y., the veteran writer and observer whose works on natural history and other subjects have made him famous among lovers of nature and good literature in the old world as well as the new, has sent to the New York *Tribune* a convincing letter in which he explains why he and other Americans have had their regard for Germany turned to aversion by the events of the present war. The spirit of Prussian militarism is unworthy of twentieth-century civilisation; and though the military machine which crushes the innocent and unoffending, and destroys things beautiful and precious, in the hope of accomplishing its purpose, may be efficient, it is neither admirable nor human. "War," concludes Mr. Burroughs, "as now waged by the Kaiser against Belgium and France, is but a high-sounding name for the collective murder and pillage and arson of a vast organised band of outlaws, and for my part I believe it is the last spectacle of the kind, and on such a scale, that the world will ever see."

IN the October number of the *Victorian Naturalist* Mr. F. Chapman describes the impression of the fruit of a Casuarina in the basalt of Victoria. Wood of an apparently existing species of the genus has been previously recorded from beneath 90 ft. of the basalt.

IN concluding his notes on a collecting trip in Borneo, in the November number of the *Zoologist*, Mr. J. C. Moulton records the discovery of a previously unknown mountain—Mount Merinjak—in the heart of the country on the border between Sarawak and Dutch Borneo. It is a flat-topped mountain of 2220 ft. elevation.

AT the Cage-Bird Show held at the Royal Horticultural Society last week, Mr. David Ezra, of 110 Mount Street, W., exhibited specimens of living humming-birds. The birds are stated to have been in London for the last six months or so. At this time of year they are kept in steam-heated cages, each furnished with a miniature furnace. The interiors are decorated with moss and orchids, the flowers of the latter furnishing the tiny inmates with nectar. When natural nectar fails, the birds are supplied with an artificial compound of honey, sponge-cake crumbs, and babies' patent food.

THE first part of an article on Japanese Lepidoptera and their larvæ, by Mr. A. E. Wileman, published in the June issue of the *Philippine Journal of Science*, is illustrated by three coloured plates of the caterpillars and pupæ of butterflies. A grass-green swallow-tail caterpillar marked with transverse golden bands harmonises in a striking manner with the trifoliate leaves of its food-plant, which have a yellow venation. Other articles in the same issue include one on Philippine medusas and a second on Philippine alcyonarians, both by Mr. S. F. Light. Two new generic types are named and described in the former and one in the latter; one of the new medusas, *Acromitus maculosus*, appears to be a very beautiful species, with a bell of fully 90 mm. in diameter. Lemnaloides, indicative of affinity with Lemnalia, is the name of the new alcyonarian.

THE fourth number of vol. ii. of the Science Bulletin of the Museum of the Brooklyn Institute is devoted to a report of the scientific results of a collecting expedition to South Georgia in a whaling brig, undertaken by Mr. R. C. Murphy during 1912 and 1913. The main objects of the trip were to obtain a collection of South Georgian birds, and skins, and skeletons of the sea-elephant. Unfortunately the latter part of the programme was not accomplished, although a considerable series of sea-elephant skulls was obtained. Despite the lack of definite arrangements for collecting invertebrates, a number of interesting specimens were secured, which, together with certain plants, form the subjects of notes by specialists embodied in the report. One of the new types is an eight-rayed starfish, described by Prof. Koehler, of Lyons, as *Anasterias octoradiata*. During the voyage to the south specimens of the male of the minute parasitic crustacean *Pandarus satyrus*—previously known only by females—were obtained on the fins of a shark.

THE October number of the *Emu* contains a translation of an article by Mr. L. Brasil (originally published in the *Bull. Soc. Linn. Normandie*), on the emeu of King Island. In the early part of last century, when Baudin's expedition landed there, that island abounded with emeus, which were, however, soon after killed off. Péron found emeus both on King Island and Kangaroo Island, and in the account of his voyage, published a plate showing one black-breasted and a second and larger whitish-breasted bird. The former, as represented by a female specimen in the Paris Museum, certainly came from Kangaroo Island, but it has been suggested by Mr. G. M. Mathews that the white-breasted bird came from King Island, and is either the extinct *Dromaeus minor*, or a second and distinct species, *D. spenceri*. This view is disputed by Mr. Brasil, who considers that both Péron's birds came from Kangaroo Island, and suggests that the whitish-breasted specimen represents the male, and the black-breasted (as attested by the Paris specimen) the female. Whether the Kangaroo Island *D. parvulus* is really distinct from the King Island *D. minor* is left an open question.

IN addition to a paper on the nomenclature of local birds and another on the probable mode of extermination of the moas, to which reference was made in the issue of NATURE of November 5, p. 265, under the title of "Ornithological Notes," the Transactions and Proceedings of the New Zealand Institute for 1913 contain communications in which several additions are made to the fauna of the Dominion and the surrounding sea. Among these is one by Mr. S. Berry, of California, on a collection of cephalopods from the Kermadoc Islands, in which two new species of Polypus (Octopus), and a new squid of the genus Abralia are named and described; two of the new forms are figured. Certain New Zealand fishes—two of which are described as new—form the subject of an illustrated note by Mr. E. R. Waite, the most generally interesting specimen being a ribband-fish (*Lophotes cepedianus*) taken in the Wellington district. Two plates illustrating a long paper by Mr. M. N. Watt on the eggs of New Zealand Lepidoptera are notable on account of the exceeding beauty of form and sculpture of some of the specimens figured. Botanists will be interested in a communication from Mr. T. F. Cheeseman on the rate of growth of the kauri pine (*Agathis australis*), and the age to which it attains. It has been asserted that one of these giant trees, with a diameter of 24 ft., is more than 4000 years old, and a second, of 22 ft. in diameter, not less than 3600. In the opinion of the author, based on the number of rings of growth and an estimate of the rate of growth at different ages, these figures should be reduced, respectively, to 1396 and 1280.

ATTENTION has been directed on several occasions in these columns to the excellent work accomplished by the Essex Field Club. Among its many activities is the assistance the members of the club render to the Essex Museum of Natural History at Stratford. The museum is under the control and management of the Higher Education Sub-committee of the Education Committee of the County Borough of West Ham, while the care and arrangement of the collections are undertaken by the council of the Field Club in pursuance of agreements with the West Ham Corporation. The club also interests itself in a second museum situated in Epping Forest, the whole of the arrangement and organisation of which has been carried out by the honorary curators, Messrs. W., B. G., and H. A. Cole, assisted by other members of the club. At the Stratford Museum is a library of some 3000 volumes on natural history and kindred sciences, and local teachers are encouraged to make free use of them. Facilities for class teaching at the museum have been arranged, and teachers may also borrow duplicate specimens for demonstration. The excellent work in these directions which is being done by the Essex Field Club shows how much enthusiastic local societies can assist in scientific education.

IN two recent papers Dr. W. E. Agar continues his studies on heredity and the life-cycle in the Daphniidæ. The larger paper, on "Experiments on Inheritance in Parthenogenesis" (Phil. Trans. Roy. Soc., No. B 323), consists of a very interesting study of inheritance in parthenogenesis. As is well known, Johannsen and others maintain that within a "pure line" there is no inheritance of size-variation; all such variability is regarded as due to environment, and not inherited. These conclusions have been criticised by Prof. Karl Pearson, who adduced the work of Warren on Daphnia and an Aphid as being opposed to them. Agar has made very full experiments with the Daphnid, *Simocephalus exspinosus*, supported by less extensive work on other Daphnids and on the Aphid Macrosiphum. He bred many generations from single females hatched from ephippia, and although when the ancestral correlations are worked out in a population derived from a number of ex-ephippio females, these correlations are considerable (0·3–0·6), yet the parental correlation is in general no greater than the grandparental, or even great-great-grandparental. When, however, a population is produced from a single ex-ephippio female, there is no correlation at all between parents or earlier ancestors and offspring. The ancestral correlation in the first case is due to the presence of many genotypes among the population; within the single genotype the correlation vanishes. The paper contains many other interesting points which cannot be alluded to in a short space. An earlier paper (in the *Journal of Genetics*, iii. (1914), p. 179) shows that in Simocephalus the idea of an inherent reproductive cycle is mistaken, and that the production of males probably depends on certain unknown factors acting in a cumulative manner over several generations.

THE December issue of the *Fortnightly Review* contains an article by Mr. J. B. C. Kershaw on the effect of warfare upon commerce and industry. He shows that the fluctuations of our trade during the past half-century have been largely independent of the wars that have been carried on by our own and other countries. The effect of wars upon the trade of this country will be measured to a large extent by the degree of their interference with the fundamental occupation of agriculture in the countries involved, and the results will be manifest, not at the moment, but in the year or years directly following the war.

WE have referred occasionally to the useful and somewhat laborious compilations of information relating to ice in the Southern Ocean contained in the monthly meteorological charts of the Indian Ocean issued by authority of the Meteorological Committee. The chart for December gives a table showing the number of instances, for each of the twelve months in the years 1885–1913, of reports that have reached the Meteorological Office. Out of a total of 1694 reports, 258 were for the year 1893 and 305 for the year 1906. The largest number of reports have been from ships traversing the South Atlantic, and mostly between Cape Horn and 40° S., and between 30° and 60° W., and the smallest number were from ships in the South Pacific; but it is pointed out that absence of ice in certain parts cannot be taken as proof that none existed. The highest of the bergs was 1700 ft. (June, 1884, 44° S., 49° E.); those of 1000 ft. are comparatively numerous. Bergs varying from five to twenty miles in length are frequently sighted south of 40° S.; and the tables show that icebergs extending from six to fifty miles in length are "far from uncommon" in the Southern Ocean.

IN the November issue of *Symons's Meteorological Magazine* "The Practical Utility of a World Bureau of Meteorology" is again urged by Mr. W. M. Hays and Mr. H. H. Clayton (see NATURE, October 1). The suggestions include: (1) the use of telegraphic weather reports from all available parts of the globe, for framing estimates of the effect of weather changes on crops, and (2) the unification and improvement of meteorological services generally. If such a scheme were really practicable as regards daily or seasonal weather forecasts, there could be little question of its general utility. The authors' own views upon the subject are supplemented by the opinions of eminent meteorological authorities, and in our issue of February 26 Dr. Shaw referred to the desirability of daily weather reports for the whole globe. To have any chance of success, such a plan as that now in question should (we presume) be recommended by the International Meteorological Committee as a body, but all efforts towards the creation of an independent institution at six international meetings, at least, led to no favourable result. The great enterprise of the U.S. Weather Bureau in establishing a daily service for the northern hemisphere may eventually aid the solution of the much more ambitious problem.

IN NATURE for October 15 we referred to the reported invention, by an Italian professor named Argentieri, of a "pocket" system of radio-telegraphy. We now learn from an Italian source that a gentleman of this name has been demonstrating a system of telegraphy before an Italian Government Committee, but what are the advantages claimed for the apparatus, and what its success, are at present being kept a secret by the parties concerned.

THE value of magnetic tests as a means of determining the changes which occur in paramagnetic materials at high temperatures is well illustrated by a paper by Prof. Honda and Mr. T. Soné on the changes of structure of certain iron and chromium compounds, which appears in the August number of the Science Reports of the University of Sendai, Japan. From their observations it appears that although at very high temperatures magnetite, Fe_3O_4, is more stable than hæmatite, Fe_2O_3, at temperatures below 1300° C., the reverse is the case, and that magnetite, once it is heated above 1100° C., is almost entirely converted into hæmatite, and remains hæmatite on cooling again to ordinary temperatures. This deduction from the magnetic observations has been confirmed by weighings. Heating to 1300° C. appears to produce no structural change in chromic oxide, Cr_2O_3, but chromium trioxide, CrO_3, appears to undergo two non-reversible changes.

IN a paper read before the Royal Society in 1909 Mr. S. Kinoshita showed that an α particle projected through a photographic film is capable, throughout the whole of its range, of making any grain of silver chloride it strikes developable. Since then, in company with Mr. H. Ikeuti, he has been using this method of tracing the paths of the α particles, and some of his results are reproduced in the September number of the Proceedings of the Tokyo Mathematico-Physical Society. The α particles were obtained from the end of a needle which had been rubbed on a metal surface previously exposed to radium emanation. The end was brought close up to or into contact with the photographic plate. After development the plate shows under the microscope a series of developed grains lying in straight lines radiating from, and forming a halo round the region of contact, extending 0·054 millimetre beyond the outside rim of the contact patch. These grains are distributed through the thickness of the photographic film, and are due apparently to the α particles from radium-C. Another series of developed grains close to the surface of the film appears to be due to α particles projected tangentially to the surface from active material slightly above it. A few grains still further afield the authors ascribe to β particles.

Sunset "afterglows" resembling those seen after the memorable Krakatoa eruption were recorded on various occasions during the autumn and winter of 1913–14. We have now received from Prof. Ignazio Galli the third of a series of reports dealing briefly with these observations, this report being reprinted from the *Atti della pontifica Accademia romana dei nuovi Lincei*, vii., read last June. The phenomena were noticed for the first time at Rome on July 13, 1913, and about the same time at Bagnères de Bigorre, in the Pyrenees. The most noticeable display seems to have occurred on November 29, when it was recorded in France, Italy, Belgium, and England. At Rome the phenomenon was observed in a greater or less marked degree from February 15 onwards until April 10, but while in the typical afterglow the colour passes gradually from yellow through orange, sometimes mauve to a deep crimson, only the yellow and orange, sometimes only the yellow, were observed in the western horizon at Rome towards the end of this period. On the other hand, marked effects were recorded by Krebs in Holstein on December 31, when the moon added to the effect. The February glows were observed at Brussels, and particularly on February 19 in Morocco, where they were supposed at first to be due to an aurora borealis. In China, Father Corvillard describes fine displays on October 30, 1913, and April 18, 1914. Assuming these effects to be due to volcanic dust, as in the case of Krakatoa, Prof. Galli refers them to the eruptions of Katmai, in Alaska, on June 6, 1912, Asama-Yama in June 1913, Mount Benbow, in the New Hebrides, on December 6, and Sakarishima, in Japan, on January 11, 1914. These eruptions, especially the last, were accompanied by copious emission of dust, but whether the later date observations, particularly the Chinese one of April 18, were due to the last eruption, can scarcely be decided definitely on the evidence now submitted by Prof. Galli.

An interesting paper on the presence of salicylic aldehyde in soils is contributed to the Journal of the Franklin Institute by Dr. Oswald Schreiner and Mr. J. J. Skinner. From certain soils, especially from some which had been used for intensive culture and greenhouse work, marked traces of an aldehyde could be extracted which showed the qualitative properties of salicylic aldehyde. The aldehyde extract was found to exercise a marked toxic effect on plant growth, and as the proportion of aldehyde is largest in the case of heavily manured greenhouse soils which have become "sick," there seems to be a relationship between the "sickness" and the proportion of aldehyde present. On the other hand, only a relatively small number of the poor soils examined showed the presence of the aldehyde, owing perhaps to the presence of other toxic substances. The material extracted by the aldehyde method was in all cases extremely small, and frequently gave no aldehyde reaction, although exercising marked toxic effect. What the harmful constituent in such cases is cannot yet be stated. In many instances the extract was not only not harmful, but exercised a stimulating effect on plant growth.

To the *Popular Science Monthly* for November Mr. R. Hugins contributes an interesting article on civilisation as a selective factor, in which it is contended that, contrary to the view generally put forward by writers in recent years, more particularly by Weismann and Wallace, there has been a real improvement of civilised man by an "agency at once powerful, comprehensive, and continuous." This agency may be designated the "elimination of the anti-social." The effect of this influence in modifying individual and national character is traced in its many forms, such as the elimination of the criminal, voluntary withdrawal, including suicide, occupational and geographical withdrawal, and, possibly most active of all, military selection, which by eliminating in the past large numbers of the predatory and intractable members of society has had the curious result that there has been an actual improvement of the military value of civilised races taking place side by side with the development of the moral character of those races. The reason for this apparent paradox is to be found in the fact that the same moral qualities have been selected through the elimination of the anti-social as are essential in the best armies—virtues such as obedience, the habit of discipline, self-control, and steadfastness.

We have received a copy of a pamphlet entitled, "English, French, and German Vocabulary for Water Supply in the Field," prepared by Mr. Philip Parker, of 25 Victoria Street, S.W., for members of the expeditionary force. The pamphlet contains, in addition to what is implied by its title, a number of sentences in the three languages well calculated to be of great use to the soldier inquiring from a foreigner with regard to water supply. The words in the vocabulary, although necessarily not numerous, appear to be well chosen; the author, however, is apparently not very well informed as to some of the foreign equivalents of chemical terms, and some of the chemical formulæ are wrong. The pamphlet concludes with some instructions for the disinfection of water by chloride of lime. These notes are somewhat laconic and appear to supplement or emphasise other instructions on the same subject. The suggestions for a rough and ready method of determining the quantity of chloride of lime required are decidedly ingenious, but we fear that not only the suggested dose, which apparently works out at about three parts of active chlorine per million parts of water after fifteen minutes' contact, but, more particularly, the time of contact (fifteen minutes) of the water with the disinfectant are considerably too low for safety. Probably two or three times the dose with ten to fifteen hours' contact would be none too much to render a polluted water reasonably safe, and surely in a matter of this kind it is better to err on the side of safety. Apart from this, the pamphlet fulfils a very useful purpose, and we congratulate the author on the service he has rendered to our troops by producing it.

OUR ASTRONOMICAL COLUMN.

COMET NEWS.—A postcard from the Central Bureau at Copenhagen gives the elements and ephemeris of comet 1914*e* (Campbell), or comet 1914*d* (Lunt). The comet is faint, being of about the eleventh magnitude, but the following ephemeris, taken from the above, may be useful for those observers equipped with large telescopes:—

	R.A. (true) h.	m.	s.	Dec. (true) °	′	Mag.
Dec. 3	22	0	8	+11	18·9	
5		1	35	11	38·2	10·9
7		3	4	11	57·3	
9		4	36	12	16·1	11·1
11		6	10	12	34·7	
13		7	45	12	53·1	11·2
15		9	22	13	11·3	
17	22	11	1	+13	29·4	11·4

Delavan's comet (1913*f*), now to be observed before dawn, has the following positions continued from the same source as stated last week:—

	R.A. (true) h.	m.	s.	Dec. (true) °	′	Mag.
Dec. 5	15	58	38	+0	49·4	5·3
7	16	2	29	−0	9·9	
9	16	6	16	−1	7·8	5·4
11	16	9	59	−2	4·3	

A CENTRAL BUREAU FOR TRANSMISSION OF ASTRONOMICAL NEWS.—In this column for October 15 attention was directed to the fact that in consequence of the war there was no central bureau for transmission of astronomical news. A circular has now come to hand to the effect that Prof. Elis Strömgren, of the Copenhagen Observatory, has taken over the management of the bureau. The circular, dated November 3, reads as follows:—"I have the honour herewith to inform you that according to an agreement made between Prof. Kobold, of Kiel, as the publisher of the *Astronomische Nachrichten*, and myself, the management of the 'Zentralstelle für Astronomische Telegramme' during the present war has been passed over to me. Consequently, I ask you to let communications for the Zentralstelle be addressed to me until further notice."

THE RECENT ECLIPSE EXPEDITION FROM MEUDON.—M. Deslandres records in the *Comptes rendus* for November 16 (vol. clix., No. 20), a brief account of the expedition sent by the Meudon Observatory to observe the late total solar eclipse at Strömsund, in Sweden, the observers being M. Bosler, of the Meudon Observatory, and M. Block, of the Lund Observatory. They were equipped with an equatorial of 8-in. aperture, carrying two spectrographs and a photographic camera with coloured screens; the spectrographs were so arranged to record the regions λ780 to 500 and λ500 to 360 separately. While the results given are considered only as preliminary, it is mentioned that the first spectrograph has recorded the existence of a new, intense, and sharp radiation superposed on the continuous spectrum of the corona. The wave-length is given as λ637·5. This red ray, which, as is stated, is not chromospheric or has not been recorded as such, is attributed to the corona. On the other hand, the ordinary coronal radiation, the green radiation at λ530, is stated to be absent from the plate. M. Deslandres is inclined to conclude that this new radiation is special to epochs of minimum of solar activity.

SPECTRA OF NOVÆ AT A VERY LATE STAGE.—In this column for June of last year (vol. xci., p. 382) a brief account was given of Prof. Barnard's observations in that year of the magnitudes of the new stars which had been discovered from time to time. These stars had passed outside the reach of spectroscopic observation, so little was known about their physical condition. The general observed routine of the sequence of spectra of nova indicated that they, in their last stages, presented a nebular spectrum, the most prominent line being that at λ5007. Hartmann, however, in 1907 directed attention to the case of Nova Persei (1901) the spectrum of which in its later stages no longer exhibited the chief nebular lines, but presented a spectrum identical with that of the Wolf-Rayet star B.D. +35° 4001. The question whether all novæ behave in a manner like Nova Persei becomes of great importance, because it may help to elucidate any explanation of the origin of novæ generally. In this connection the 60-in. reflector of the Mount Wilson Observatory, combined with a slit spectroscope carrying a 60° prism, and collimator and camera lenses of about 16 cm. focal length, has been put to a useful purpose by investigating the spectra of faint novæ. In the *Astronomical Journal* for October (vol xl., No. 3, p. 294) Messrs. W. S. Adams and F. G. Pease describe the results of their photographic research, which they carried out at the end of last and the beginning of this year, in connection with four faint novæ. The following table gives the names of the new stars in question, their magnitude, the durations of exposure, and the date:—

	Magnitude	Duration of exposure Hours	Date
Nova Aurigæ of 1891 …	14	16	1914 March 18–22
Nova Persei of 1901 …	12·4	8	1913 November 27
Nova Lacertæ of 1910..	12·5	11·5	1913 October 29–31
Nova Geminorum No. 2 of 1912 … … …	10	2	1914 February 22

The results of the investigation may be summed up as follows:—The authors find that the spectra of Nova Aurigæ and Nova Persei are essentially identical with the spectra of some of the Wolf-Rayet stars, as Hartmann noted in the case of Nova Persei. Nova Lacertæ and Nova Geminorum are not yet old enough to have reached the stage when the chief nebular lines disappear, so that they cannot yet exhibit the permanent spectrum of spent novæ. It is suggested that the permanent spectrum of novæ, taken in connection with their agreement with some of the Wolf Rayet stars, and the well-known agreement of distribution relative to the Milky Way of both novæ and Wolf-Rayet stars, point to a close connection between some of the latter and temporary stars in the later stages of their history. The hypothesis that the phenomenon of a temporary star is due to a star entering a nebula is deserving of some attention, since the disappearance of the chief nebula lines is coincident with the emergence of the stars from the nebula.

THE ANTWERP "GAZETTE ASTRONOMIQUE."—It is proposed to recommence the publication of the *Gazette Astronomique* formerly issued by the Astronomical Society of Antwerp. The occupation of that town by the Germans occasioned the temporary suspension of the *Gazette*, and many of its supporters have now found hospitable homes in this country. A number of English astronomers, on the initiative of Mrs. Fiammetta Wilson, of Bexley Heath, are interesting themselves in the matter by financial assistance and the promise of literary contributions. It is intended to restart the *Gazette Astronomique* early in January in the French and English languages. The minimum subscription will be five shillings annually, but English astronomers who are able and willing to subscribe more liberally may send half-a-guinea or a guinea as a means of more effectively aiding their unfortunate Allies in the attempt to revive their astronomical journal. It will be issued once a month unless circumstances should enable it to appear more frequently. Subscriptions and correspondence should be sent to Felix de Roy, Hon. Sec., 29 Stamford Street, London, S.E.

THE HARDENING OF METALS.

A VISITOR at the recent meeting of the Faraday Society could scarcely have failed to be struck by the fact that although the society was supposed to be discussing the hardening of metals, in reality the discussion centred almost entirely round the various theories of the hardening of steels. The reason for this was probably twofold. First, in spite of, or perhaps on account of, the considerable amount of research work that has been published on this problem it still remains the most keenly debated topic in metallurgical circles, and one on which widely different opinions have been held. Secondly, from a practical point of view it may be broadly stated that, in regard to hardening, steels are the only alloys that really matter.

Yet there can be no doubt that the council of the Faraday Society made a wise choice in the title of the topic for discussion. Even the simplest pure iron carbon steel is a complex material. Its complexity is due to the facts that (1) iron exists in at least two well-defined allotropic forms; (2) above 780° C. it is non-magnetic; below it, magnetic; and (3) carbon has a remarkable tendency to form compounds of a high degree of molecular complexity. While considerable attention has been directed to the first two aspects of the matter, the third has not yet received the attention that it deserves, and will require before a complete solution of the problem can be reached. The position, therefore, is that while steels may be the most interesting alloys to investigate it does not follow that they are most suitable. What is first of all required is a fundamental investigation of the theory of the hardening of metals from which the foregoing disturbing causes are absent. When the foundations of this have been securely laid the precise effect of the above "variables" will no doubt be elucidated by suitably chosen experiments.

This aspect of the matter was clearly seen many years ago by Dr. G. T. Beilby, who has investigated the physical mechanism of the hardening of metals such as gold, silver, and copper, which can be obtained in a high state of purity, and from which magnetic and chemical complications are absent. Until quite recently it would have been possible to say that allotropic complications were also absent, and so far as present knowledge goes they were absent in the case of gold and silver. Recent investigations by Prof. Ernst Cohen (Utrecht), however, have led him to conclude that the metals cadmium, lead, bismuth, copper, zinc, and antimony ordinarily occur as metastable systems consisting of two or more allotropic forms, so that this consideration must be kept in view. Prof. Cohen was unfortunately unable to be present at the meeting, but an important summary of his results was available and is worthy of very close study. Ordinarily the transformations from one allotropic form to another are subject to strongly marked retardations, and it is only by employing certain devices such as the addition of an electrolyte and the use of the metal in a finely divided state that the transformation velocity can be increased to such an extent that the change from the metastable to the stable form occurs within a short time. These transformations are frequently accompanied by marked volume changes leading to complete disintegration of the metal.

These recent developments do not, however, alter the fact that Dr. Beilby chose for his investigations metals of the most suitable kind from the point of view of arriving at a physical conception of the mechanism of hardening by mechanical deformation, and they enabled him to prove the existence of a thermally stable crystalline and a mechanically stable amorphous vitreous phase in each metal investigated. How far-reaching and fundamental these conclusions have proved to be is evidenced by the fact that all the papers dealing with the hardening of steels presented at the meeting incorporated and made more or less use of them. According to Mr. Humfrey, "The hard structure which can be produced in carbon steels by quenching and in certain alloy steels by normal cooling is due to the presence of a hard, amorphous solution of α iron and iron carbide." Mr. McCance's view is that the hardening is due to "interstrained" α iron, and the suppression of the carbide change. The theory of Profs. Edwards and Carpenter is that the hardness is caused by the complete suppression of the carbide change, together with the presence of amorphous layers existing at the surfaces of slip upon which copious twinning occurs when carbon steels are quenched. On this view the *final* cause of hardening by quenching is exactly the same as that of hardening by cold working, viz., the internal deformation of the crystals.

When these theories are carefully examined it is significant to note how much they have in common. All of them agree that the carbide (Ar 1) change is suppressed, a fact of very fundamental importance. The differences centre round the precise condition of the iron, and arise chiefly from differences in conclusions drawn from the magnetic condition of the alloy. They will not be adjusted until it has been settled whether iron can be magnetic in other than the α condition. Mr. McCance apparently denies that the iron in hardened steels is amorphous. It is not yet clear precisely what he means by the term "interstrain," and how it differs, if at all, from the term "internal tension," suggested many years ago by Metcalf and Langley.

Most significant of all is the fact that none of the above theories make use of β iron. This means that the controversy has essentially changed. It is no longer between the allotropists who laid chief stress on the postulated existence of a hard, stable, crystalline β iron, which was held to be primarily responsible for the hardness of quenched steel, and the carbonists, who denied this altogether, and ascribed the hardness to the action of carbon without, however, being able to explain it. The complete solution of the problem now appears to be bound up with the acquisition of a more intimate knowledge of the molecular combinations between iron and carbon in hardened steels and their variations in the hardening range of temperature. Stimulus to investigations of this character will no doubt be given by the substantial prize offered by Sir Robert Hadfield, the president of the Faraday Society, for the best research dealing with the combinations between iron and carbon. He has rendered an important service in directing attention to this difficult but neglected side of the subject.

H. C. H. CARPENTER.

AIR, CLIMATE, AND TUBERCULOSIS.[1]

IN October, 1891, Thomas George Hodgkins, of Setauket, New York, made a donation to the Smithsonian Institution the income from a part of which was to be devoted to "the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man." From this fund a prize of 300*l.* was offered in 1908 for the best treatise on the relation of atmospheric air to tuberculosis. Numerous essays were submitted to the adjudicators, and Dr. Guy Hinsdale, of Hot Springs, Virginia, was one of the successful competitors. His essay, enlarged and more fully illustrated, has now been printed in vol. lxiii. of the Smithsonian Miscellaneous Collections, Publication No. 2254. It is necessary to recite these details; otherwise it would be difficult to understand the *raison d'être* of such a work as that now before us, which is that of an enthusiastic specialist. It has its faults —many of them—it also has the virtues of its kind. It is an expanded essay. It contains an enormous amount of information; facts and figures abound, and anyone studying questions of climate, the effect of elevation, the condition under which moisture is precipitated, the action of sunlight and the like, will here find ample data for consideration. One cannot but feel, however, that to it might be applied with propriety the Scotsman's description of a "haggis" as "fine confused feeding." This is to be regretted, as one is constantly coming across evidence that if the author could only leave his authorities severely alone now and again and let us have the result of his own cogitations, a far more stimulating and quite as informative a book would have been the result.

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[1] Smithsonian Miscellaneous Collections. Vol. lxiii., No. 1. Hodgkins Fund. "Atmospheric Air in Relation to Tuberculosis." By Dr. G. Hinsdale. Pp. x+136. (Washington: Smithsonian Institution, 1914.)

Starting out from the Adirondack Forest, whither Dr. A. L. Loomis, of New York, sent patients in order that they might have the benefit of the purest and most invigorating air obtainable, and where Dr. E. L. Trudeau, who himself had benefited from the treatment, founded a cottage sanatorium in 1884, Dr. Hinsdale, after indicating the success of Dr. Trudeau's experiment, takes his institution as an example. He maintains that the condition of the atmospheric air may be of great importance in the successful treatment of tuberculosis, and that such pure air is to be obtained in the midst of an evergreen forest of more than 10,000 square miles. It was "common knowledge" in the days of Pliny that forests, especially those which abound in pitch and balsam, are beneficial to consumptives, or to those who do not gather strength after long illness, and that they are of more value than the voyage to Egypt (C. Plinii, Hist. Nat., lib. xxiv., cap. 6). Such forests are to be found in the Hartz Mountains and the Black Forest of Germany, in the Ardennes, the large American and Canadian forests, and in our own New Forest areas. Here the air is pure and moderately moist—an important feature, though one to which too little attention is paid—and the rainfall averages not too high, in order that patients may get out of doors during a considerable part of the year.

It appears that there is a slight excess of ozone in the air of forests, and this, of course, may be a factor in the treatment of consumptive patients, though it is maintained by some that ozone which, even in great dilution, irritates the lungs, the throat, and the frontal sinuses cannot be of much value in the treatment of such cases. The author ventures no opinion on this point, but quotes Lorrain Smith to the effect that oxygen which at the tension of the atmosphere stimulates the lung cells to active absorption, at a higher tension acts as an irritant and sets up inflammatory processes.

Perhaps the most important points brought out by Dr. Hinsdale in connection with forests and afforestation are that the work of raising, transplanting, and caring for trees is specially adapted to the strength of convalescent consumptives and that various forms of woodcraft, such as basket-making and the manufacture of small rustic articles, may easily be carried on under healthful conditions in the forest.

The site of a model sanatorium for consumption may, with advantage, be above the snow-line for some part, if not for the whole, of the year. Here there is less organic matter in the atmosphere, and, as demonstrated by Boycott and Haldane, it is the organic matter in the air and not an excess of carbon dioxide that gives rise to the discomfort, headache, etc., suffered in badly ventilated rooms; moreover, the anaphylactic phenomena corresponding to those noted in "horse asthma" or "stable asthma," may be avoided by changing the air even when considerable quantities of carbon dioxide are allowed to persist. It is interesting to learn that the consumptive daughter of the discoverer of oxygen, Dr. Joseph Priestley, was condemned to pass a considerable time in a cow-house in order that the diminished oxygen and increased carbon dioxide "might lower the inflammatory action associated with the disease." Dr. Beddoes, who had charge of the patient, thought that this treatment would not be acceptable to all his patients, "as it seemed to me hopeless to propose residence in a cow-house, I advised that the patient should live during the winter in a room fitted up so as to ensure the command of a steady temperature. This advice was followed. Double doors and double windows were added to the bedroom, the fireplace was bricked up round the flue of a cast-iron stove for giving out pure air." Dr. Hinsdale's comment on this note is that the doctor persisted in his plan of treatment until the patient died. Dr. Hinsdale, from his own experience, makes a further point on which sufficient attention had not been concentrated. It is not the expired air of tuberculous patients that carries infection, but the sputum and the tiny drops of moisture coughed by the patient that carry the bacilli and communicate the disease to others, but, be it remembered, that many of the bacilli carried into the nose, mouth, and upper air passages soon lose their activity or are extruded.

In his chapter on the influence of sea air the author mentions that Aretaeus, about 250 B.C., recommended sea voyages to the patient strong enough to endure them, for the cure of consumption, and that about three hundred years later Celsus prescribed a voyage from Italy to Egypt, or, failing this, that the patient should pass a large portion of his time sailing on the Tiber. Such treatment has fallen out of vogue, probably because long distances are now covered in such short periods that changes in temperature and atmospheric conditions occur far too rapidly, and the patient is unable to accommodate himself to them sufficiently rapidly. Patients who are fond of the sea and who have the opportunity of travelling in a sailing ship in roomy, well-ventilated cabins, and under medical supervision, even now receive great benefit from this treatment which, however, should not be used indiscriminately.

It would be difficult to follow the author through his disquisitions on warmth, moisture, fog, and the like, but it may be accepted that he favours quiet, bracing atmospheres, through which the sun's actinic rays can pass but little obstructed. These, he thinks, are to be found on high ground, where also expansion of the thorax almost invariably occurs, though, following our own surgeons who send their cases of surgical tuberculosis to Margate, he recommends sea air for such cases. High grounds, he maintains, are natural gymnasia where patients living out in the open air can *graduate* their exercise and form and absorb their own tuberculin. Dr. Hinsdale insists that rest is essential to the well-being of the patient during the febrile phases of phthisis, and that a patient must never *over-exercise*, as he is greatly tempted to do in clear, bracing climates. Finally, he comes to the very common-sense conclusion that when all is said and done it is the man behind the climate who is able to treat a tuberculous patient with greatest advantage, and that even he can do little without the hearty co-operation of his patient.

Many interesting questions are raised by Dr. Hinsdale; he gives numerous excellent and interesting illustrations of shelters, of institutions, of methods of treatment, of the results of heliotherapy and immobilisation in plaster; he delineates patients before treatment, patients during treatment, in plaster jackets and in sun baths, and patients after treatment, and altogether makes us feel that the publication is what it pretends to be, a collection of data that will interest those engaged in the treatment of tubercular patients. With all this it is a constant matter for regret that the author has not put a little more of himself into his work. For what it is, however, we are grateful, and it may be anticipated that it will be very widely consulted.

THE BRITISH ASSOCIATION IN TASMANIA.

THE Tasmanian contingent of the British Association left Melbourne by the s.s. *Loongana* on Saturday, September 5, at 10.30 p.m., and arrived at Launceston about 5 p.m. on the following day. The party numbered twenty-one. Owing to an unfortunate dislocation in the boat service it was impossible to carry out the Launceston portion of the original programme, although time was found to visit the Launceston Museum on Sunday evening, under the guidance of the curator, Mr. H. H. Scott, to whose zeal and energy this excellent little museum owes so much. On the following day there was just time for a brief visit to the beautiful Cataract Gorge before leaving by rail for Hobart. Tuesday, September 8, was occupied by receptions at the Hobart Town Hall, the museum, and the university, and a luncheon at Government House, and in the evening Dr. G. T. Moody gave a lecture on some commercial aspects of education. Wednesday, September 9, was devoted to a motor excursion to Mount Wellington, the party being entertained at lunch at the Springs Hotel by the Hon. Henry Dobson, who has done so much to open up Mount Wellington as a tourist resort. Some of the party proceeded on foot from the Springs to the summit, while others devoted themselves to the collection of natural history specimens, including the remarkable "mountain shrimp," *Anaspides tasmaniae*, so characteristic of the mountain streams of the island.

On Thursday, September 10, the party divided for several excursions in the neighbourhood of Hobart, including a dredging trip to the D'Entrecasteaux Channel, which resulted in the collection of much interesting material. On the following day they left for Maria Island, on the east coast, proceeding by motor as far as Spring Bay, whence the crossing to the island was made by motor boat. Maria Island is celebrated as the scene of a former convict settlement, and afterwards of various industrial experiments of the "wild-cat" type, in which much capital appears to have been sunk. The limestone rocks, of Permo-Carboniferous age, are crowded with fossils, which may be collected in unlimited quantity both in the "Fossil Cliff" on the shore and in an extensive quarry excavated to supply the now defunct cement works. Perhaps the most conspicuous of the fossils in the cliff is the large bivalve Eurydesma, but numerous others occur in profusion. A dredging trip in the neighbourhood of the island, in about 20 to 25 fathoms of water, yielded an enormous profusion of sponges in great variety, including some very remarkable and novel Calcarea. On the island itself numerous land planarians were collected, and the botanists were delighted to find the curious Tmesipteris growing upon tree-ferns.

The party left Maria Island early on Sunday, September 13, and after crossing to Spring Bay visited the kitchen middens at Little Swan Port. These were found to consist almost entirely of immense quantities of oyster-shells, forming a deposit several feet in thickness, and extending over a good many acres. The curiously rough chipped "flints," so characteristic of the Tasmanian aborigines, were found here in abundance. After lunch at Spring Bay the party motored back to Hobart through very beautiful scenery. This concluded the main part of the programme, but the zoological visitors remained by special invitation to take part in a collecting expedition to the Great Lake. Before leaving Hobart on this trip Prof. Dendy gave an address to the Royal Society of Tasmania on progressive evolution, and Dr. W. M. Tattersall delivered a public lecture on the depths of the sea. A visit was also paid to Mrs. Roberts in Hobart, whose collection of living Tasmanian and other animals excited much interest, two "native devils" (Sarcophilus) with young ones being particularly admired.

The party for the Great Lake started from Hobart on the morning of September 16 in three motor cars, and reached their destination the same evening. It had been hoped that they would be able to obtain a good deal of marsupial and monotreme material for the committee appointed by the council of the British Association for that purpose, but these hopes were only very scantily fulfilled. No monotremes were seen, though tracks and burrows of Ornithorhynchus were found on the shore of the lake, and only a very few wallabies and rat kangaroos were obtained to represent the marsupials. The invertebrate fauna of the neighbourhood, however, yielded a large number of extremely interesting specimens. The shrimp-like Paranaspides was obtained in quantities by dredging in the lake, and under the stones along the shore were found Phreatoicus, numerous freshwater planarians (one of remarkably large size), etc.

The forest around the lake has unfortunately been ravaged by fire, but laborious turning over of the fallen timber yielded many most interesting cryptozoic animals, including the land nemertine (*Geonemertes australiensis*), which was fairly common, a number of species of land planarians, and several specimens of the rare Tasmanian Peripatus (*Ooperipatus insignis*). The visitors returned to Hobart on September 22, and some of them left Launceston for Melbourne by the s.s. *Rotomahana* on the following day.

In every respect the Tasmanian visit must be regarded as a very great success. The thanks of the visiting members are due to all who contributed so generously to this result, and especially to his Excellency the Governor of Tasmania (Sir W. Ellison-Macartney) and Lady Ellison-Macartney, to the Premier and other members of the Government, to local scientific men, such as Mr. R. M. Johnston, Mr. Rodway and Mr. May, and, above all, to Prof. T. Thomson Flynn, the able and energetic organiser of the visit.

A. D.

AUSTRALIA AND THE BRITISH ASSOCIATION.[1]

IT is just one hundred and forty-four years since the first scientific expedition from Great Britain to Australia visited Moreton Bay. The expedition consisted of his Majesty's barque *Endeavour*, a vessel which had been built for the coal trade and was chosen because she was an excellent sea-boat, and required a smaller complement of officers and men than a regular ship of war. It was commanded by Lieut. James Cook, and included Mr. Joseph Banks, a gentleman "possessed of considerable landed property in Lincolnshire, who although he had received the education of a scholar, had long desired to know more of nature than could be learned from books," and who afterwards, as Sir Joseph Banks, was for no fewer than forty-one years president of the Royal Society; Dr. Solander, a Swedish botanist and pupil of Linnæus, who was attached to the newly established British Museum, and who, along with two accomplished draughtsmen and a secretary accompanied the expedition at Mr. Banks's expense; Mr. Charles Green, one of the assistants of the Astronomer Royal at Greenwich; and other scientific observers. These gentlemen, in the words of one of the biographers of Captain Cook, "quitted all the gratifications of polished society and engaged in a very tedious, fatiguing, and hazardous navigation with the laudable views of acquiring knowledge in general, of promoting natural knowledge in particular, and of contributing something to the improvement and the happiness of the rude inhabitants of the earth."

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[1] Concluding discourse delivered before the British Association at Brisbane on August 31 by Sir Edward Schäfer, F.R.S.

I would not be so bold as to suggest that the present expedition has as high aims as those of its predecessor, nor would it be fair to press too closely the comparison between our present expedition and the certainly more famous expedition of Captain Cook, which first brought a ship-load of scientific men to this then inhospitable shore. But whether we may be lacking in quality or not as compared with the members of that expedition, at least we make up for it in quantity; and where the first expedition found nothing but rudeness and inhospitality on the part of the inhabitants, the members of our expedition have met with all the signs of an enlightened civilisation and have received the warmest and most hospitable of welcomes.

Could anyone authoritatively have foretold to Captain Cook and his companions what they were likely to find here if they were to revisit this spot, after a lapse of time which is after all measured only by the lifetime of two individuals, how great would have been their astonishment! That a fine city of nearly a hundred and fifty thousand inhabitants should be overlooking the magnificent bay which they christened "Moreton's," which is now traversed in every direction, independent of wind and tide, by huge, weird vessels, where its solitude was then only relieved by the presence of their own comparatively small sailing-ship; that some three hundred people, devoted to science, should have faced the dangers and other inconveniences of the deep in order to meet and compare notes with kindred spirits amongst the inhabitants of the opposite side of the world; and that large meetings should assemble for the discussion of scientific problems in magnificent halls, in places where the members of the first expedition found no habitations and none but the rudest of savages—these it must be admitted are facts which would be calculated to surprise the staid eighteenth-century men of science and mariners brought by the *Endeavour*, who were still in the habit of getting about quite satisfactorily to themselves with only such aids to locomotion as nature herself had provided, and who were not accustomed, as we are, to hear of a first-class scientific discovery every month or so.

Although I have spoken of the visit of Captain Cook's expedition to this spot, it is well-known that he did not actually land at Brisbane, nor did he even ascertain the existence of the Brisbane River, although we are told that it was inferred by some members of the expedition, from the appearance of the sea water, that a considerable stream must open into the bay. The wind was unfavourable for approaching the land more closely, or, as Cook tells us, he would certainly have made this the subject of a special investigation. But even although you—*i.e.* your predecessors in title—never had the chance of seeing the famous seaman in the flesh, that is no reason why his visit to your harbour should not be adequately commemorated, and I venture to suggest that the erection of a suitable memorial of so memorable an occasion as the visit to Moreton Bay in the month of May, 1770, of Captain Cook and his company will—when the present troubles are over—be an appropriate tribute to the deathless memory of the most famous navigator that our race has produced.

I have introduced the subject of Captain Cook's visit because it serves as a convenient illustration of the value to the world of the organised pursuit of any branch of science, however abstract and however removed from application to one's ordinary daily avocations it may at the time appear. For be it remembered that this expedition in the *Endeavour* was primarily intended for observing the transit of Venus at Otaheite, and was fitted out by George III.'s Government on the pressing representations of the Royal Society. Incidentally, and after the primary object had been carried out, the commander had instructions to make discoveries and surveys of the unknown parts of the South Seas; and the east coast of New Holland was visited after several months had been spent in cruising amongst the islands of the Pacific and circumnavigating and incidentally surveying the complicated coast line of New Zealand. Less than a month after leaving Moreton Bay the *Endeavour* struck a coral reef, and after being got off proved to be damaged to so serious an extent that but for a piece of rock having become broken off and embedded in one of the largest holes made in her bottom no amount of pumping could have kept her afloat. This incident of the embedded rock, and the fact that soon after she struck and whilst she was still on the rock a dead calm supervened might naturally have been regarded at the time as a special dispensation of Providence to preserve the expedition from destruction, but the historiographer of the voyage frankly admits that if Providence is to receive credit for stopping the leak it should have its share of blame for permitting the vessel to get on the rock at all.

"It will perhaps be said," says Mr. Hawkesworth, "that in particular instances evil necessarily results from that constitution of things which is best upon the whole, and that Providence occasionally interferes and supplies the defects of the constitution in these particulars; but this notion will appear not to be supported by those facts which are said to be providential; it will always be found that Providence interposes too late, and only moderates the mischief which it might have prevented. But who can suppose an extraordinary interposition of Providence to supply particular defects in the constitution of nature who sees those defects supplied but in part? It is true that when the *Endeavour* was upon the rock off the coast of New Holland the wind ceased and that otherwise she must have been beaten to pieces; but either the subsiding wind was a mere natural event or not; if it was a natural event Providence is out of the question, at least we can with no more propriety say that providentially the wind ceased, than that providentially the sun rose in the morning. If it was not a mere natural event, but produced by an extraordinary interposition, correcting the defect in the constitution of nature, tending to mischief, it would lie upon us to maintain the position; to show why an extraordinary interposition did not take place rather to prevent the ship's striking, than to prevent her being beaten to pieces after she had struck."

But whatever part Providence may have taken in the transaction, it may be added, to give honour where honour is due, that she was materially assisted by the ingenuity of one of the midshipmen (Mr. Monkhouse), who carried out a method he had learned in the merchant service of introducing oakum and wool into the leak by rubbing a staysail with pieces of these materials loosely attached to it along the damaged bottom; so that a single pump was afterwards sufficient to keep the vessel afloat until a convenient place was found where she could be beached and repaired; although all hands that could be spared to work at three pumps were before scarcely able to keep the water down, and the men would soon have had to relinquish the attempt from sheer fatigue. One contemplates with dismay even at this distance of time the blank in geographical knowledge which would have persisted for many a long year if Captain Cook had met his fate off Cape Tribulation in 1770 instead of in Karakakoa Bay in Hawaii somewhat less than nine years later.

I am now going to ask you to make a jump with me of about sixty years and of half the circumference of the globe in order that we may be present at the birth of the British Association. This event, which was to prove of much greater importance than the founders of the Association could have conceived, occurred in the year 1831. A number of gentlemen, amongst whom are included the well-known names of Brewster, Lyell, Vernon Harcourt, Murchison, and Phillips, who were interested in science and believed in its value to the community, met in the month of September of that year in the ancient city of York. The object of the gathering was to try to spread a knowledge of the progress of science throughout the country by presenting new scientific facts, not only to other men of science, but also to the general public. These functions were already efficiently performed for London by the Royal Society and by the Royal Institution respectively, but nothing of the same nature had been hitherto provided for the provinces. With this laudable object it was decided to establish a peripatetic society which would visit provincial centres in Great Britain and Ireland in turn, and thus carry the torch of scientific enlightenment even to remote parts of the United Kingdom.

I think that if the founders of the British Association could have been told that in eighty odd years the Association would be carrying this torch to the Antipodes and would be holding a meeting of the Association at a place in New South Wales—of which Queensland was then a part—which had not even been marked on the map, their astonishment would have been nearly as great as that which I have supposed that Captain Cook and his companions would have experienced sixty years earlier could they have received similar information. That the holding of this meeting should be possible is due to the progress of the sciences which the Association was established to assist, and certainly very largely to the advances in what our American cousins call "transportation"—a term which had a somewhat more restricted meaning in the early days of this community. At the time of that memorable meeting in York—although it is true the Liverpool and Manchester Railway had been opened in the previous year—journeying by land still depended in its most advanced form upon the mail-coach, a vehicle which was regarded by our great-great-grandfathers as the *ne plus ultra* of speed and convenience, although we ourselves look back upon it as merely an interesting and picturesque phase in the evolutionary history of methods of locomotion. And it was not until seven years later that the first passenger steamer crossed the Atlantic, and the doom of the sailing ship was pronounced. Probably our own great-great-grandchildren will regard our present methods in much the same light as we do the old mail-coach and sailing ship, and wonder that we should have been so long satisfied with the servitude of land and water when the freedom of the air was to be had for the asking.

It must be admitted that this establishment of a scientific association for the provinces of the United Kingdom was a brave project at a time when four days or more were required by a coach to cover the two hundred miles intervening between London and York—a distance which now occupies an express train less than four hours, and which can be done by aeroplane in little more than half that time. York was, however, a relatively convenient centre, to which many lines of coaches converged from all parts of the country. Subsequent meetings held in Oxford, Cambridge, Edinburgh, Dublin, and Bristol must have presented greater difficulties, and for scientific men from remote parts to get across country to some of these places a month would scarcely have been too much to devote to the to-and-fro journey. Yet nowadays we think less of the voyage to and through Australia than our forefathers did of the journey from London to Edinburgh, so easy and comfortable is travelling rendered by the palatial steamers and luxurious trains which are at our disposal.

Those of us who are getting on in life remember when the Association first began to think of extending its sphere of operations beyond the confines of the United Kingdom. This was about thirty years ago, and the occasion was an invitation from Canada that we should include Montreal in our visiting list. The older and more conservative elements of the Association were up in arms at the suggestion. It was prophesied that such a change would break up the Association; that most of the regular *habitués* would not attend; that the meeting would have no scientific value, and would be little more than a sort of glorified picnic. It was also argued that if we go to Canada the Australians will be wanting us to visit their country, and this was regarded as indeed a *reductio ad absurdum*! But not only were these gloomy prognostications not fulfilled, but the dreaded sequel has come about without any manifest appearance of absurdity, and we have been in Australia for nearly a month, honoured guests of the Commonwealth, more than delighted with our reception, and hoping that we may leave behind us some elements of permanent benefit, although we cannot but feel that we shall be taking away, not only in general knowledge and experience, but also in some matters which are exclusively scientific far more than most of us have been able to bring.

These visits to the Dominions, which at one time seemed so impossible and are now so easy, exhibit the Association from a point of view which could, as I have said, never have been taken by its founders, however clearly they may have figured out the scientific benefits to be derived from its annual reunions. They furnish the most direct evidence possible of the bond which unites us into that singular body, the Empire, a body of which we are each and all inordinately proud, although it only consists of a congeries of States which are knit together by what in times of peace has sometimes seemed a perilously slender tie. The religious and political views which are prevalent in the several constituents of this inchoate body may and do differ *toto coelo*, and one might almost expect these differences to act centrifugally and tend in the direction of disintegration. In the matter of commerce and manufactures, also, there have been in the past, and still here and there survive, doubts as to whether our interests are identical. But that our scientific interests are the same is a doctrine which is received everywhere without question, and this community of scientific interests serves to bind together the constituent parts of the British Empire none the less firmly because it also helps to link us severally and collectively to the rest of the civilised world. For scientific knowledge and the benefits which accrue from it are never confined within the limits of any barrier, either of race or nationality, but are free to all people and to all nations. This fact has been long recognised, and we find in the history of Captain Cook's voyages a remarkable illustration of the principle (of community of scientific interest), in the rescript sent during his third voyage of discovery in the year 1779 by the Secretary for the Marine Department of France, with whom England was then at war, directing all captains of armed vessels who may meet "that famous navigator, Captain Cook," to treat him as a commander of a neutral and allied Power. A similar order was issued to all captains and commanders of armed ships acting by commission from Congress by the Ambassador of the United States to the Court of France, directing them to treat Captain Cook with all civility and kindness, affording him as a common friend to mankind all the assistance in their power, and assuring them that by so doing they might depend on obtaining the approbation of Congress. Franklin was, it is true, mistaken in the confidence he expressed regarding the sentiments which were likely to actuate Congress, the members of which displayed less enlightenment than their distinguished representative—but this is a commodity with which members of Parliament and Congress are not always too well provided even at the present day.

About the time of that first scientific expedition which I have ventured to use as a convenient introduction to a Brisbane audience, Watt was engaged in carrying out those improvements in the construction of machines which ushered in the age of steam and steel, and were eventually destined to enable us, within the period of our academic holidays, to hold our annual gathering at this end of the globe. Chemistry was beginning to feel its feet. Priestley had prepared carbon dioxide, and Lavoisier soon afterwards isolated oxygen. Discoveries were in the air, although the progress of science was very perceptibly checked by the long wars and general social disturbances which followed the French Revolution. After these wars ensued a period of exhaustion, during which commerce was only very gradually recovering her position, and although science was progressing, it was with relative slowness. Nevertheless, in Great Britain the important investigations of Humphry Davy into the chemical constitution of the alkalies, resulting in the discovery of several new metals, form a marked exception to this general statement; and Davy's successor, Faraday, was, in the twenties of the nineteenth century, commencing those brilliant researches which, with the previous work of Oersted and Ampère, form the basis of our knowledge of electricity and magnetism. The first publication of Faraday's discoveries of voltaic induction and the relation of electricity to magnetism took place in the year of the foundation of the Association, and the last of the more important of his papers on this subject appeared in the Philosophical Transactions of 1851.

Two or three years before the York meeting, the absolute barrier which was thought to exist between the organic and inorganic world was broken down by the discovery of Woehler that urea—until that time considered a purely animal product—could be prepared synthetically from inorganic materials. In biology matters had not moved so much. Nearly everybody still believed, in spite of the brilliant and suggestive theories of Lamarck and Laplace, that the round world and all that therein is was the result of a single act of creation which had occurred some four thousand odd years previously; and another thirty years were to elapse before that comfortable belief was shattered by the epoch-making observations and brilliant generalisation of Darwin and Wallace. The mere enumeration of everything that has grown out of the investigations and discoveries of the great men I have mentioned would much more than occupy the whole time allotted to this discourse. All the resources of modern civilisation, whether for peace or war, are indeed the direct result of the researches in physics and chemistry to which I have alluded, although many of these researches may have seemed at the time to be of purely scientific interest and to have no application to human needs. One can imagine a member of the audience at the Royal Institution asking Davy, "What can be the possible use of knowing that gases can be liquefied?" although no such question would be likely to be put to the present distinguished occupant of Davy's chair; or another member telling Faraday that his demonstration of the rotation of one coil of wire within another might make a pretty enough toy, but could never be of any practical utility.

Similar questions and remarks are still made whenever a discovery which is purely scientific is announced. Shades of Galileo and Galvani! Will the world never profit by the lessons which the history of science teaches it? Has it not again and again been shown that the establishment of a fact which at first sight seemed to furnish no possible utilitarian application has eventually far outweighed in its importance any number of discoveries which are capable of being immediately utilised in commerce or manufacture? You have, I suppose, all heard of the eminent man of science who thanked God that a discovery he had made could never, so far as he could see, be of the slightest use to any living creature! Probably he is apocryphal; but we see that there is some basis for his expression of gratitude, since it has again and again occurred that discoveries which appeared to be of no utility were pregnant with immense issues. Who could have thought it possible that Pasteur's investigation into the constitution of racemic salts would have led to a complete revolution in our knowledge of medicine and surgery, and in our methods of treatment, a revolution so complete as even to involve the use of a different kind of language to express the difference of conception of disease which characterises modern medicine as compared with that which was practised even so recently as the seventies of the last century? And although it is mainly to Lister that we owe the application of Pasteur's chemical and biological researches to surgery, we must not forget that their application to disease in general was due to the great French chemist.

It is not given to every man, as it was to Pasteur and Lister, to witness the full development of the discoveries which their experiments have initiated, or to receive during their lifetime the honour which is their due, and in most cases little or no benefit comes in the way of the actual discoverer. It is the man who applies the scientific discovery to the exigencies of manufacture or to commerce who reaps the harvest of the golden shekels. Not that we grudge it to him! But I would none the less impress upon him and upon people in general the importance of encouraging and assisting in every possible way investigations in pure science, which of themselves bring no pecuniary reward to the investigator, but which may nevertheless prove of inestimable value to the community. The labourer is worthy of his hire—but the hire which the scientific labourer is considered worthy of is a mere pittance when compared with the colossal incomes which result from the application of his researches. It should be the aim of Governments to attract the best intellects to the pursuit of science, but few, if any, offer inducements to such to devote themselves to this study, a fact which fortunately does not always deter them from engaging in it. Virtue is, we know, her own reward, but the rewards offered by the pursuit of commerce, of law, and even of medicine are gilded with something much more tangible than the self-gratification which follows the pursuit of pure science. The first necessity of life is to be able to live, and unless a man can live, and not only live, but live comfortably and sure of freedom from pecuniary anxiety, he is not likely to produce the best work his intellect is capable of. I wonder when this will be understood. Be sure that the nation which first understands it will come to the front. Unfortunately, we find that things are in this respect no better, but rather worse, in democratic communities than in some of the supposedly effete monarchical systems of the Old World. Democracy must look to her laurels, or she will find herself left behind in the race for knowledge—and knowledge will always be power, as long as mankind continues to exist.

The remedy lies in the education of the people. It is certainly remarkable how little importance seems to be attached to scientific instruction as a part of general education. Science is, indeed, incidentally tacked on to education schemes, and a certain proportion of the coming generation are taught a little physics and chemistry, and sometimes a still smaller modicum of biology and geology; but our children, although trained in many subjects which are interesting in themselves, are, as a rule, not instructed in those which have a close relationship to the problems of their daily life. How few people know anything of the constitution and properties of things around them, things which are essential to their existence, such as air and water, and substances which serve them for food. How few know anything about themselves! If the proper study of mankind is man, how great is the neglect of that study! Surely it is more important that a man should understand how the world around him is constituted and how he himself lives and moves and has his being within it than that he should be efficient in ancient and modern languages, or in mathematics, or that his knowledge of history and geography should be as extensive and peculiar as Sam Weller's acquaintance with London! The appreciation of science by the people cannot come until the general ignorance regarding matters scientific is dispelled. And there is so much to learn, and so little time to learn it, that no child should be considered too young to be taught something about himself and his environment. Doubtless this would involve a change in the system of education which now everywhere prevails, but that it would be a change for the better and would conduce to the health and happiness of mankind cannot, I believe, be gainsaid.

We know what the past of science has produced: we have the evidence all around us. But what of the future? What is in store for our successors? Speculation regarding this is even more fascinating than the study of the past. Can we form any kind of anticipation regarding possible discoveries? In pure science I imagine not. Discoveries in this always come unexpectedly; at any rate, they are always unexpected so far as the world in general is concerned; which, indeed, only very slowly recognises them as real discoveries. Our speculations regarding the future must therefore be mainly confined to applications of what is already known, or to extensions along the lines which recent investigations have been laying down. But even so, the possibilities which are opening out to us are almost limitless. We are proud of the progress of what we Englishmen call the Victorian era, but is it not likely that this will be vastly eclipsed by the second Georgian? It took more than half a century to develop the steam engine, nor have we by any means as yet exhausted its possibilities. But the internal combustion engine has made more progress in less than half that time, and to it we already owe the supersession of animal traction on our roads, and the use of the air as the medium by which locomotion is or very soon will be effected. The applications of electricity which are already in use are dazzling in their variety, but we have scarcely touched the fringe of the applicability of the Hertzian waves, and the vast possibilities of radio-activity are still *terra incognita.* Who can reasonably doubt that we shall soon be flying safely through the air faster than the swiftest bird, and that our means of intellectual communication will be at least as much advanced as that of the transportation of our goods and bodies?

The rate of progress of chemical knowledge at the present time is no less extraordinary than that of physics. Every day shows an advance in our acquaintance with the structure of the molecules of which the elements and their compounds are built up. Our information regarding the complex molecules which compose living substance is receiving such continual additions and so much is already known about it that we cannot fail to recognise that the problems of life itself must sooner or later find their complete solution within the scope of physical chemistry. The attempts of science to solve the mysteries of the universe recognise no limitation: "thus far shalt thou go and no farther" is a command which can never be obeyed by the scientific inquirer. But to attempt to foretell coming scientific events even in the near future —merely to endeavour to guess at the kind of truths which are likely to be discovered—is a futile task. For the investigations of modern science are being extended to depths which have hitherto been regarded as unfathomable, and we can have no idea to what they will eventually lead us. Neither the infinitely great nor the infinitely small any longer presents serious difficulties to the investigator, by whom both the stars in their courses and the atoms which compose the molecules of matter—nay, even, the all-pervading and imponderable æther itself—are called to yield up their secrets.

We may be justly proud of what has been achieved, but let us not fail to remember with Newton that "the vast ocean of truth" still "lies" for the most part "undiscovered before us." However marked may be the progress of science, her individual votaries must always feel a sense of humility at the little the best of them is able to contribute towards the general result. Not that this thought need dishearten any scientific worker. For there is no other way of erecting an edifice, however stately, but by laboriously piling brick upon brick, stone upon stone, girder upon girder. And if our successors assemble here at the end of another century, can it be doubted that the subjects which they will discuss will show as much advance in knowledge on those with which we have been dealing during this visit as the science of the present day transcends that of the beginning of the nineteenth century? I think that even if we had no other use for a future existence it would, at any rate, be interesting to our ghosts to be able to follow the progress of human knowledge and to observe how problems which during their life on earth were regarded as insoluble are ultimately solved by the *labor et ingenium* of those who come after us—an occupation which would I believe, be more congenial to most of them than those employments to which, by the general consensus of theologians, they are expected to devote their infinity of leisure. In the meantime, it is for us to lay our bricks well and truly, even although the opportunity is given to very few of us to witness a definite result of our labours. For we may be sure that every addition to scientific knowledge will help to promote the general happiness of mankind, and will tend to dissipate that ignorance which, in spite of the four intervening centuries, still remains as much "the curse of God" as ever it was in the days of Shakespeare.

Since this is the last general assemblage of the association which is to be held in Australia, it will, I trust, not be considered inappropriate for me to spend the few minutes which remain in endeavouring to formulate in the best manner I can—although the best will, I am conscious, be but imperfect—the impression which has been produced upon your visitors from the mother country by what they have seen and heard, read and learned of this antipodean country, its resources and inhabitants. To say that that impression is profound seems a commonplace, but there is no other word which can adequately express the actual fact. Your splendid organisations flooded us with information regarding the Commonwealth in general and the individual States which compose it in particular even before we started on our voyage here; and I suppose that we each and all of us have utilised some of the time which on a passenger ship is not occupied in eating and sleeping in taking in and digesting a part, at any rate, of the mass of statistics that the compilers of the volumes you have presented us with have provided. We have in our extensive journeyings had an opportunity of seeing some of the fine scenery which the country possesses. We have become familiar with your principal cities and with the magnificent streets and buildings which they contain. We have been exhaustively informed regarding the products of the country, both natural and artificial. We know, or can know if we like, the number of sheep, cattle, and horses which are annually reared; and although I have noticed that the number of rodents has nowhere been recorded in the literature with which we were provided, we may yet live to see the manufacture of coney sealskin develop into an important Australian industry. We are, or can be if we like, familiar with the output of gold and copper, of coal and opals; with the progress of the timber trade; with the development of the railway system, of telegraphs, of posts. We have made the acquaintance of your educational systems, and have had the opportunity of closely observing your universities and other institutions for advanced studies. We have seen something of the prosperity of your commerce and industries, and have been duly furnished with interesting and valued information regarding their growth and activity. We have even had dangled before our eyes statistics regarding the wages which you pay to your employees, until some of us have probably thought that it might be worth while to stay in the country and become Australian working-men, whose pay—with the possible exception of that of the San Francisco bricklayer—appears to be pitched on a higher scale than that of the same class anywhere else in the world, and in some cases to touch, if it does not even exceed, the salary of the average European professor. We shall indeed—some of us—go home knowing more about Australia than about our own country, and you may expect within a twelvemonth or so a perfect shower of books and magazine articles on Australia and the Australians; for does not every globe-trotter think he is capable of writing about the countries he has visited, even when he is not furnished with more information than is to be obtained in the average guide-book?

There is one phase of your development which cannot fail to interest not only the visitors to your shores, but the outside world in general, and that is the experiments you are making in dealing with such social problems as industrial disputes and the regulation of trade and manufacture. Many of these experiments are enough to make Adam Smith turn in his grave; but the proof of the puddin' is in the priein' o't, and if you are able to carry on your industries successfully to the contentment of employer and employed, and without the constant threat of strikes or lock-outs, you will find no lack of imitators on the other side of the globe.

A political experiment which, although not peculiar to this side of the world, may yet be said to occupy a more prominent position in it than in other parts where it has been adopted is the referendum. As you are probably aware, our politicians at home have always made a fetish of Parliament—by which they mean the House of Commons—and one of the assumptions which underlies the British constitution is that as long as a given Parliament exists—and it may exist with us for half a dozen years—it represents the settled opinion of the country, *i.e.* of a majority of the electors. But everybody knows that this opinion, so far from being settled, is often very unsettled, and in any case it need scarcely be said that questions may arise within the Parliamentary period which have never been before the electors at all. Whether for good or ill, we cannot but admit that the adoption of the referendum at home would soon settle certain vexed questions which have been, and still are, the source of a vast amount of political inquietude and even of grave social disturbance.

Although the nature and character of the inhabitants of a country is a question which is always treated prominently by travellers who are narrating their experiences, it is one which can scarcely be freely discussed in the presence of so large an assembly of the subjects of discussion. Nor has the difficulty been reduced by the extraordinary kindness with which we have been received by the inhabitants in every place at which we have stopped. But this, at any rate, can be said, viz., that—with the exception of a greater amount of warmth and spontaneity than we at home are accustomed to exhibit, combined with a certain tone of personal independence which, in the British Isles, is more common in the northern parts than elsewhere—there is no obvious difference in character between the man in the street here and the man in the street at home. Any change that has taken place is, at any rate, for the better, as is exemplified by the way in which your citizens of all classes have come forward, even in time of peace, to be trained for the defence of their country. If our responsible statesmen would imitate yours and give the lead on this vital question of citizen-service, instead of waiting to see which way the electoral cat is likely to jump, the people of Great Britain would not be long in following the example which the sense of patriotism of Australia has set them, and they could then afford to smile at the idea of an invader setting foot within our little sea-girt land, sure in the prospect of its remaining the centre of "a greater Empire than has been."

And I think I may venture to assert that if we had adopted at home the principle of universal service for the defence of that Empire, a principle which that great man and soldier Lord Roberts has so persistently advocated, the present iniquitous war would never perhaps have been set on foot.

I suppose that, on the whole, one thing regarding the population of Australia that strikes the visitor from the Old Country more than another is the enormous disproportion between the extent of habitable country and the number of actual inhabitants. That a continent nearly as large as Europe should have far fewer inhabitants than London alone, and a density of only about one seventy-fifth that of Europe is an obvious incongruity. But it is one which will naturally tend to right itself as the years roll by; and since the necessity for a great increase of population in order to develop the country is forcing itself upon the attention of those who guide the fortunes of the several States, we shall no doubt witness, in the near future, a much more rapid rise of population than has occurred in the past. Fortunately, the increase which has taken place is of the right sort. Australia has, to its credit, long refused to be the dumping-ground for the dregs of the Old World, and is developing a race which will, in the course of a few decades, probably be more purely British, both in physique and character, than any other extensive area of population in the world, not even excepting the mother country. No nation has greater possibilities for the future. Assured of peace and of freedom from outside interference, there is nothing to impede that advance which, in her adopted motto, Australia puts before herself as her constant aim; and her invitation to us to visit her shores was, we may take it, not intended merely as an act of graceful hospitality, but also as a means of promoting within her borders that advancement of science which, as its title expresses, is the essential object of the existence of the British Association.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—Mr. T. V. Barker, fellow of Brasenose College, has been appointed University lecturer in chemical crystallography for five years from January 1, 1915; and Mr. A. G. Gibson, Christ Church, as University lecturer in morbid anatomy for five years from the same date.

Speaking at the annual meeting of the Sheffield University on Monday, the Vice-Chancellor, Mr. H. A. L. Fisher, said he believes that when the war is concluded it will be possible for England very largely to step into the place hitherto occupied by Germany. If our universities will only be a little more imaginative and try to reproduce some of the perfection of organisation which prevails in Germany, and has brought eternal honour to the German nation, our universities may become cosmopolitan in the sense in which Oxford was the great cosmopolitan university of the Middle Ages. It is only since the Reformation that English universities have become, in a sense, provincial. In certain regions of applied science there is no reason why in the next fifteen or twenty years Sheffield should not be the technical capital of Europe.

A copy of the annual report of the 118th session, 1913–14, of the Royal Technical College, Glasgow, has been received. Judged by the tests now universally applied the session was one of the most successful in the history of the college. The number of day students continues to increase steadily; but the most satisfactory feature is the accession to the number of those attending full courses, resulting in a great expansion in "student-hours" of actual attendance and work. The total number of "student-hours" of the day classes was 237,908, an increase of more than 15 per cent. on the corresponding figure for the preceding session. The scheme affiliating the college to the University of Glasgow came into operation at the beginning of the session, with satisfactory results. Forty-one matriculated students were in attendance on qualifying classes within the college, and of these twenty-eight were following a full course of study. At present the scheme applies only to degrees in engineering, but the advisory joint-committee, established by the University and the college, has prepared a draft Ordinance for degrees in applied chemistry, which is now under consideration. It is hoped that this Ordinance will receive the approval of the Privy Council during the coming session, and thus give to college students in chemistry the opportunities for graduation now open to students in engineering. The report points out it is believed that more than a thousand past students have now joined H.M. Forces; the First Company of the 3rd Glasgow Battalion H.L.I. consists of college students exclusively. The Carnegie Trust for the Scottish Universities recently considered the position of the college in view of their allocation of grants for the next quinquennium. In the result, the trust made a grant to the college of 1000*l.* per annum for five years. Of this sum, 100*l.* is for the maintenance of the library, 300*l.* for provisional assistance, and 600*l.* towards a superannuation scheme. The college received during the year, among other gifts, legacies of 5000*l.* from the late Mr. William Weir, and 500*l.* from the late Mr. J. C. Alston.

SOCIETIES AND ACADEMIES.

London.

Royal Society, November 19.—Sir William Crookes, president, in the chair.—A. **Mallock**: Note on the circulation of the atmosphere.—Sir Sidney **Burrard**: The origin of the Indo-Gangetic Trough, commonly called the Himalayan Foredeep.—G. W. **Walker**: Approximately permanent electronic orbits and the origin of spectral series. In this paper an endeavour is made to find a basis of explanation of spectrum series in terms of strict electrodynamics. The illustrative system consists of a spherical nucleus radius a, with a positive electric charge E and a fixed magnetic moment μ. It is constrained to be fixed and may be regarded as corresponding to a comparatively massive atom. A single corpuscle with a negative charge e and mass m is free to move under the influence of the forces exerted on it by the nucleus. When the effect of radiation is neglected circular orbits are shown to be possible. The circumstances, stability, and range of these orbits are examined in detail, both for orbits outside and inside the nucleus. Only the inside orbits appear to have a bearing on the problem in hand. It is found that there is a class of circular orbits in each of which the angular momentum of the corpuscle has the same value. This result has already been obtained by Conway, who sought to identify the value with Planck's unit. It is here shown that these orbits occur only if the charge of the nucleus is concentrated mainly at the surface, or if the material of the nucleus has a large dielectric ratio. Another class of circular orbits exists. They lie in the equatorial plane of the nucleus, and have different angular momenta. The formulæ, although possessing the same general features, are not so simple as those for the Conway orbits. The effect of radiation is next considered. The motion of the corpuscle gives rise to radiation disturbance inside and outside the nucleus, while the nucleus produces radiation in the manner proved by Lamb. The disturbance can be analysed into terms of electric and magnetic type. In each case a series of values of r/a are found for which the reaction on the corpuscle becomes very small, and so it is argued that the corpuscular orbit for which r/a has one of these values is comparatively stable and gives a spectral line. Following Lamb in supposing that the dielectric ratio is great, we find that from the Conway orbits with magnetic type of disturbance we get the recognised Balmer formula, while with the electric type of disturbance we get a series closely resembling the Rydberg formula. In addition to these series we ought to get Lamb's series from the nucleus, but quite consistently with the theory they may be in the infra-red or the ultra-violet. In order to fit the formula of Balmer type with the hydrogen series, and taking $e/m = 1\cdot7 \times 10^7$, $\mu = 1\cdot8 \times 10^{-21}$, the radius of the nucleus required is about 2×10^{-10} cm.—W. **Jevons**: Spectroscopic investigations in connection with the active modification of nitrogen. IV.—A band spectrum of boron nitride. (1) The interaction of active nitrogen and boron trichloride or methyl borate develops a band spectrum extending from λ6371 to at least λ2140, with well-defined heads degrading throughout towards the red. (2) The new spectrum consists mainly of two distinct systems, in the less refrangible of which each band consists of four heads forming two close doublets. The more refrangible system has single heads, and thus resembles the silicon nitride spectrum described in a previous paper. (3) The wave-lengths of the heads have been measured, and the wave-numbers in each system have been classified and represented by formulæ in the usual manner. (4) Chemical and spectroscopic evidence has established that the origin of the spectrum is boron nitride. Boron, carbon, and silicon compounds are thus alike in developing nitride spectra in the nitrogen afterglow. (5) The boron nitride bands, like those of cyanogen, are produced in the electric arc spectrum where they occur, together with bands of the oxide.—Prof. E. **Wilson**: An additional note on the production of high permeability in iron. It has been shown that if stalloy in laminated ring form is subjected to a magnetising force due to a direct current whilst it is cooling through the temperature at which it regains its magnetic properties, and is at the same time shielded from the influence of the earth's magnetism, the permeability recovered at atmospheric temperature has a maximum value of more than 10,000 when the magnetic induction was of the order 6000 C.G.S. units. It had been shown previously that high values of the permeability can be obtained without the use of a special magnetic shield when iron has impressed upon it a magnetising force, due to an alternating current, during the time that it cools through the temperature at which it regains its magnetic properties. As, however, in the last-mentioned case, an iron tube was used to enclose the specimen and became heated with the specimen, it was thought desirable to discover whether the high value of the permeability can be obtained when there is no question of magnetic shielding. In the present experiments the specimen of stalloy in ring form was allowed to cool inside a sealed fire-clay crucible, when subjected to a magnetising force of 13 C.G.S. units, and at atmospheric temperature a permeability of more than 10,000 was again obtained. Further experiments have been made with stalloy in the form of straight strips. The specimen which consisted of a number of strips side by side was wound with a magnetising coil and then placed inside an iron tube. On allowing it to cool through the temperature at which magnetic quality is regained, when subjected to a magnetising force due to a direct current, the improvement in maximum permeability, when at atmospheric temperature, was small, and had apparently disappeared when re-tested at the maker's works.

Royal Anthropological Institute, November 17.—Prof. A. Keith, president, in the chair.—The Hon. John **Abercromby**: The prehistoric pottery of the Canary Islands and its makers. In the museums of the Grand Canary, Teneriffe, and Palma a considerable number of prehistoric vessels are preserved. Anthropologists are agreed that the natives of the archipelago at the time of its conquest in the fifteenth century were a composite people made up of at least three stocks: a Cro-Magnon type, a Hamitic or Berber type, and a brachycephalic type. These natives were in a Neolithic stage of civilisation. Their arms were slings, clubs, and spears. Most of the people went naked, except for a girdle round the loins, and there was no intercommunication between the islands. Their stone implements were of obsidian or of basalt. Only four polished axes are known from the Grand Canary and one from Goméra. The axes are of chloromelanite, and of a type contemporary with megalithic structures in France. The first colonists probably brought the knowledge of making pottery with them, but each island developed an individuality of its own. Even the painted ware of the Grand Canary appears to be of local origin and not due to external influence. Although undoubted Lybian inscriptions in the Grand Canary and lava querns of Iron age type prove that the archipelago was visited before its conquest by the Spaniards without affecting the general civilisation of its inhabitants.—Major E. R. **Collins**: Stone implements discovered in South Africa during the Boer war. The paper dealt mainly with finds in or on the terrace-gravels, the principal sites being Burghersdorp, in Cape Colony, Spytfontein in the Orange Free State, and Vereeniging, Meyerton, Panfontein, Klerksdorp, and Vlekfontein, in the Transvaal. A few palæoliths from undisturbed South African gravels have been recorded, but several more were brought to light in digging shelter-trenches, and certain finds on the surface confirm the view that the early Cave-period of Europe is also represented in South Africa, quite apart from the supposed Bushman series.

Geological Society, November 18.—Dr. A. Smith Woodward, president, in the chair.—A. **Dunlop**: A raised beach on the southern coast of Jersey. The raised beach is on the eastern slope of the ridge between Le Hocq and Pontac. The section, facing northwards, shows the following succession of beds from above downwards:—

	Thickness in feet	inches
(1) Earthy loam, with a layer of rubble ...	4	0
(2) Stiff brownish-red clay	1	0
(3) Yellow loamy clay, containing water-worn pebbles and angular fragments	3	4
(4) Coarse brown sand	3	6
(5) Water-worn pebbles, closely packed in a matrix of coarse brown sand ...	4	6

The rock beneath is fine red granite. The section is terminated at its western end by sloping rock. The base of the section is about 50 ft. above mean sea-level. The pebbles are of the red granite of the locality, but some are of diabase and of quartzite, as well as a few of flint. Flint pebbles have also been found in two low-level raised beaches, and flint-pebbles and fragments have been noticed in the yellow clay. A raised beach was recently pointed out in the railway cutting near the eastern railway station. Its base is about 55 ft. above mean sea-level, and it is covered by a thick bed of yellow loamy clay.—Prof. S. J. **Shand**: Tachylyte veins and assimilation phenomena in the granite of Parijs (Orange Free State). The district is the neighbourhood of Parijs township, situated on the Vaal River, and lies upon the northern portion of the Vredefort granite-mass. The so-called "granite" near Parijs is a red and grey streaky gneiss, often traversed by veins of red pegmatite; these are of a later period of consolidation than the rest of the rock. The grey facies of the gneiss results from assimilation of the country-rock by an ascending magma; while the red facies represents the residual portion of the same magma. The tachylytic veins everywhere intersect the granitic rocks. These veins range from a fraction of an inch to 2 ft. in thickness, but in the thicker veins there are numerous inclusions of the country-rock. They are irregular in form, thickness, and direction, and are due to the intrusion of a basic magma which underlay the district. The author brings forward evidence to prove that the position occupied by the tachylyte is independent of tectonic features, but follows directly from solution and corrosion of the granitic rocks by the basic magma.

Linnean Society, November 19.—Prof. E. B. Poulton, president, in the chair.—A. J. **Wilmott**: Discovery of *Hydrilla verticillata*, Casp., in Esthwaite Water. This is a small lake to the west of Windermere; and the discovery was made by Mr. Pearsall.—C. H. **Wright**: The Mosses and Hepaticæ of West Falkland Islands, from the collections of Mrs. Elinor Vallentin. Having made a collection of phanerogams and ferns, which formed the basis of a paper published in the Journal of this society, (Botany, vol. xxxix., 313-39), Mrs. Vallentin returned to the Falkland Islands and made collections of the lower Cryptogams. The present paper contains the determinations of this collection and attempts to bring together the information previously published on other collections. The genera represented are either terrestrial or aquatic, and the species much resemble those from the northern hemisphere. Many are capable of resisting cold and drought, such as they are exposed to in these windswept islands. Very little affinity is shown with the flora of New Zealand and the subarctic islands to the south of it.—R. S. **Bagnall**: Thysanoptera of the West Indies.

CAMBRIDGE.

Philosophical Society, November 9.—Prof. Newall, president, in the chair.—Sir J. J. **Thomson**: Experiments with slow kathode rays.—Prof. J. **Zeleny**: The conditions of instability of electrified drops, with applications to the electrical discharge from liquid surfaces. Experiments on the electrical discharge from liquid drops formed at the ends of small tubes, show that under some conditions the surface of the liquid is subject to more or less agitation. When the surface is examined under the instantaneous illumination of a spark, small masses of liquid are seen to be pulled away. This behaviour is shown to have no direct connection with the electrical discharge but is explained by the surface becoming unstable under the action of the electric forces, the observed electrical current being carried across the gas gap by minute electrified drops. The square of the potential at which the instability begins is directly proportional to the radius of the drop and to its surface tension, a relation which has been verified by experiment. Whether an electrical discharge, from a given surface, may begin before the surface becomes unstable depends upon the gas used and its pressure, since these quantities determine the starting potential for the electrical discharge.

MANCHESTER.

Literary and Philosophical Society, November 3.—Mr. F. Nicholson, president, in the chair.—W. C. **Jenkins**: Note on the aerolite which fell at Upholland, near Wigan, on October 13.—H. **Day**: Variation in a Carboniferous brachiopod. The species chosen for investigation was *Reticularia elliptica*, as a common and typical representative of the "*Spirifer glaber*" group, regarding which considerable doubt has existed as to the distinction of species and genera. This type is readily distinguished by its fine, reticulate ornament, but great variation is shown by individuals in respect of relative length, breadth, and thickness. The length, breadth, and thickness of each of 1000 specimens, collected from one spot, were accurately measured, and the ratios L/B and L/T were then determined. Each of these ratios was found to vary according to a symmetrical simple variation curve, leaving no doubt as to the specific unity of the assemblage. It was further ascertained that variation in respect of either ratio was nearly independent of that in respect of the other. There is, however, a slight tendency for breadth and thickness to vary together in relation to length, in such a way that both ratios on the average diminish as the individual increases in size.

November 17.—Mr. R. L. Taylor, secretary, in the chair.—F. W. **Atack**: The salt-formation of oximes. After outlining the current theory of oxime-isomerism, due to Hantzsch and Werner, the author pointed out that there is a notable discrepancy between the formulæ first deduced by Hantzsch and Werner in support of their theory and those in agreement with the Beckmann change, and this discrepancy has never been explained. Tschugaev's statement that only the so-called α-dioximes form characteristic salts with metals of the eighth group of the periodic system is incorrect, the author having obtained similar salts with the so-called γ-dioximes. It has been found that in case an "oxime" group forms a hydrochloride, it does not form such salts. New methods for the purification of oximes were outlined.

DUBLIN.

Royal Dublin Society, November 24.—Dr. J. H. Pollok, in the chair.—Prof. W. **Brown**: The fatigue of nickel and iron wires when subjected to the influence of alternating magnetic fields of frequency 50 per second. The results of some experiments showed that it takes about three times longer to fatigue an iron wire than a nickel one when tested under the same conditions.—Nigel G. **Ball**: The action of pectase. The action of the pectase of *Syringa vulgaris* on a solution of pectin was investigated by determining the change in viscosity of the mixture. In the presence of electrolytes the viscosity rose to a maximum and then decreased.—W. R. G. **Atkins** and G. O. **Sherrard**: The pigments of fruits in relation to some genetic experiments on *Capsicum annuum*. In Capsicum fruits red is dominant to yellow, chocolate, and orange. The reds and chocolates have oily pigments in plastids. These are distinguished from lycopin, carotin and xanythophyll by their ready solubility in cold alcohol and in petroleum ether.—W. R. G. **Atkins**: Oxidases and their inhibitors in plant tissues. Part iv. Peroxidase reactions of related species of Iris are similar, even though distribution of anthocyanin may be different. Alterations in peroxydase due to removal from light are not rapid enough to vitiate this conclusion. Anthocyanin is frequently present where there is no peroxydase. Well-marked inhibition patches are found in some species. Toluene water is as effective in removing inhibitor as is cyanide.

PARIS.

Academy of Sciences, November 16.—M. P. Appell in the chair.—H. **Deslandres**: Observation of the total eclipse of August 21, 1914, by the expedition from the Meudon Observatory. The expedition organised by the Observatory of Meudon made observations at Strömsund, in Sweden. Photographs were taken with two spectrographs, a brief description of which is given (see p. 373).—A. **Chauveau**: The question of the diminished resistance of enfeebled organisms to the destructive action of the tubercle bacillus. The author has previously published the view that healthy subjects, living in close contact with tuberculous patients, are as liable to contract tuberculosis as enfeebled subjects. They are all, strong and weak, equally liable to receive and cultivate the specific germs of the disease if these germs succeed in penetrating in the living state by the two usual modes of infection (respiratory or digestive). The author discusses from the public health point of view the opposite view more commonly held, and protests against erroneous interpretations of his views.—André **Blondel**: The most general enunciation of the laws of induction. Experiments are described showing that the enunciation of the laws of induction in some well-known text-books is too general.—M. **Courty**: Observation of the transit of Mercury made at the Observatory of Bordeaux, November 7, 1914.—P. **Gaubert**: Artificial macles of tin.—Marcel **Baudouin**: Discovery of a menhir remaining upright under a dune on the coasts of Vendée. The stone was found in modern Quaternary deposits and was indisputably of human workmanship.—Maurice **Lugeon**: The presence of crystalline plates in the Prealps and their signification.—H. **Colin**: The saccharogen in the beetroot.—P. **Hariot**: The marine flora of the island of Tatihou and of Saint-Vaast-la-Hougue.

CALCUTTA.

Asiatic Society of Bengal, November 4.—J. J. **Kieffer**: Chironomides du Lac de Tibériade. Six new species are described and one already known from Europe and North Africa (*Pelopia monilis*) recorded from the Lake of Tiberias.—H. **Sāstri**: Recent additions to our knowledge of the copper age antiquities of the Indian Empire. The note brings up to date the information about the copper or bronze antiquities of India by noticing some fresh material that has come to light since Mr. V. A. Smith wrote on the subject in the *Indian Antiquary*, and makes some corrections in the descriptions by Mr. Smith.

BOOKS RECEIVED.

Inaugural Address of the President, W. A. Evans, to the Members of the Leicester Literary and Philosophical Society, October 5: Wheat and its Relation to the Present Crisis. Pp. 20. (Leicester: W. Thornley and Son.)

Atti della Fondazione Scientifica Cagnola dalla sua Instituzione in Poi. Vol. xxiii. Anni 1908–12. (Milano: Tipo. Lit. Rebeschini de Turati E. C.)

The Museum of the Brooklyn Institute of Arts and Sciences. Science Bulletin. Vol. ii. No. 4: A Report on the South Georgia Expedition. Edited by R. C. Murphy. Pp. 43–101. (Brooklyn: The Museum of the Institute.)

Memorie del R. Istituto Lombardo di Scienze e Lettere. Vol. xxiii.–xiv. della Serie III. Fasc. I. Saggio di un Indice Lessicale Etrusco. By E. Lattes. Pp. 66. (Milano: U. Hoepli.)

The Trisection of Lines and Angles: Geometrical Researches in the Twentieth Century. By C. Guezouni. Pp. v+58. (London: International Scientific Association.) 1s. net.

The Royal Technical College, Glasgow. Annual Report on the 118th Session. Pp. 69. (Glasgow: Royal Technical College.)

Elementary Practical Chemistry. By J. E. Myers and J. B. Firth. Pp. viii+194. (London: C. Griffin and Co., Ltd.) 4s. net.

A First Book of Geology. By Dr. A. Wilmore. Pp. vi+141. (London: Macmillan and Co., Ltd.) 1s. 6d.

Insects Injurious to the Household and Annoying to Man. By Prof. G. W. Herrick. Pp. xvii+470. (London: Macmillan and Co., Ltd.) 7s. 6d. net.

Life of Sir John Lubbock, Lord Avebury. By H. G. Hutchinson. Two vols. Vol. i. Pp. xiv+338. Vol. ii. Pp. x+334. (London: Macmillan and Co., Ltd.) 30s. net.

Falske Analogier med henblik Lighed, Slægtskab, Arv, Tradition og Udvikling. By W. Johannsen. Pp. 114. (Kobenhavn: G. E. C. Gads Forlag.)

The Essex Field Club Year-book and Calendar for 1911–12. Edited by W. Cole. Pp. 32. (Stratford: Essex Museum of Natural History.) 1s. net.

Bartholomew's Orographical Map of Central Europe, showing Political Frontiers. (Edinburgh: J. Bartholomew and Co.) 2s. 6d. net.

Bartholomew's War Map of Europe and the Mediterranean. (Edinburgh: J. Bartholomew and Co.) 1s. net.

City and Guilds of London Institute. Department of Technology, Exhibition Road, London, S.W. Report on the Work of the Department for the Session 1913–14. Pp. 466. (London: J. Murray.)

Annalen der k.k. Universitäts-Sternwarte in Wien. Band xxiii., Nr. 1. Photographische Aufnahmen des Halleyschen Kometen und der Kometen des Jahres 1911. By Dr. J. Rheden. Pp. 28+Tafel 9. Band xxv., Nr. 1. Untersuchungen über das Rothschild-Coudé und den Coudespektrographen der k.k. Universitäts-Sternwarte in Wien. By A. Hnatek. Pp. 67. (Wien.)

On the Trail of the Opium Poppy. By Sir A. Hosie. 2 vols. Vol. i., pp. viii+300. Vol. ii., pp. 308. (London: G. Philip and Son, Ltd.) 25s. net.

University Correspondence College Calendar, 1914–1915. Pp. 217. (Cambridge: Burlington House.)

Meteorological Office. Geophysical Memoirs. No. 9: On the Relation between the Velocity of the Gradient Wind and that of the Observed Wind. By J. Fairgrieve. Pp. 189–207. No. 10. The Effect of the Labrador Current upon the Surface Temperature of the North Atlantic, and of the latter upon Air Temperature and Pressure over the British Isles. By Commander M. W. C. Hepworth. Part 2. Pp. 211–220. (London: Meteorological Office.) 1s. and 8d. respectively.

Ice Observation, Meteorology, and Oceanography in the North Atlantic Ocean. Report on the Work carried out by the s.s. *Scotia*, 1913. Pp. 141. (London: H.M.S.O.; Wyman and Sons, Ltd.) 4s. 6d.

Maps, Charts, and Diagrams to Illustrate the Above. Plates 35. (London: H.M.S.O.; Wyman and Sons, Ltd.) 2s. 6d.

The Modern Factory: Safety, Sanitation, and Welfare. By Dr. G. M. Price. Pp. xx+574. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 17s. net.

Constructive Text-Book of Practical Mathematics. By H. W. Marsh. Vol. iii. Technical Geometry. Pp. xiv+244. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5s. 6d. net.

Mathematical Monographs. No. 14. Algebraic Invariants. By Prof. L. E. Dickson. Pp. x+100.

(New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5*s*. 6*d*. net.

Outlines of Organic Chemistry. By Prof. F. J. Moore. Second edition. Pp. xi+325. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s*. 6*d*. net.

Pattern-Making. By F. W. Turner and D. G. Town. Pp. v+114. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 4*s*. 6*d*. net.

Above the Battlefield. By R. Rolland. Pp. 17. (Cambridge: Bowes and Bowes.) 6*d*. net.

Germany's War-Inspirers, Nietzsche and Treitschke. By Canon E. McClure. Pp. 44. (London: S.P.C.K.) 4*d*. net.

The Germ-Cell Cycle in Animals. By Dr. A. W. Hegner. Pp. x+346. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

Geometry of Four Dimensions. By Prof. H. P. Manning. Pp. ix+348. (London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

A Foundational Study in the Pedagogy of Arithmetic. By Dr. H. B. Howell. Pp. xi+328. (London: Macmillan and Co., Ltd.) 5*s*. 6*d*. net.

Department of Commerce. Technologic Papers of the Bureau of Standards. Nos. 30 to 35. Washington: Government Printing Office.)

Department of Commerce. Scientific Papers of the Bureau of Standards. Nos. 217, 219 to 222. (Washington: Government Printing Office.)

Department of Commerce. Bulletin of the Bureau of Standards. Vol. x. Nos. 2 and 3. (Washington: Government Printing Office.)

Department of Commerce. Circular of the Bureau of Standards. Nos. 16 and 44. (Washington: Government Printing Office.)

Report of the Commissioner of Education for the Year ended June 30, 1913. Vol. i. Pp. liv+931. Vol. ii. Pp. vi+700. (Washington: Government Printing Office.)

Department of Commerce. U.S. Coast and Geodetic Survey. Results of Observations made at the U.S. Coast and Geodetic Survey Magnetic Observatory at Vieques, Porto Rico, 1911 and 1912. Pp. 102. (Washington: Government Printing Office.)

Department of Commerce. U.S. Coast and Geodetic Survey. Terrestrial Magnetism. Results of Magnetic Observations made by the U.S. Coast and Geodetic Survey in 1913. Pp. 52. (Washington: Government Printing Office.)

State of Connecticut. Public Document. No. 24. Thirty-seventh Annual Report of the Connecticut Agricultural Experiment Station. Being the Annual Report for the Year ending October 31, 1913. Pp. xviii+441. (Hartford, Conn.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. lxvi. Part 2. Pp. 227–555. (Philadelphia.)

Connecticut Geological and Natural History Survey. Vol. iv. Bulletins 16 to 21, 1910–13. (Hartford, Conn.: State Geological and Natural History Survey.)

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 3.

ROYAL SOCIETY, at 4.30.—The Thermophone: A New Form of Telephone: M. de Lange.—Hermann's Phenomenon: G. S. Walpole.

CHILD STUDY SOCIETY, at 7.30.—Self Expression through Language with Older Children: Margaret Corner.

LINNEAN SOCIETY, at 8.—An Ecological Journey in South America, Illustrated by Lantern Slides: R. C. McLean.—*Isoëtes japonica*, A. Br.: C. West and H. Takeda.

FRIDAY, DECEMBER 4.

GEOLOGISTS' ASSOCIATION, at 8.—The Fossil Flora of the Pettycur Limestone: Dr. W. T. Gordon.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Thomas Hawksley Lecture: Pumping and other Machinery for Waterworks and Drainage: (by the late Mr. W. B. Bryan) read by B. W. Bryan.

MONDAY, DECEMBER 7.

SOCIETY OF ENGINEERS, at 7.30.—Mechanical Appliances for the Painless Killing of Animals: S. M. Dodington.

SOCIETY OF CHEMICAL INDUSTRY, at 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Types of Political Frontiers in Europe: Prof. L. W. Lyde.

ROYAL SOCIETY OF ARTS, at 8.—The History and Practice of the Art of Printing: R. A. Peddie.

WEDNESDAY, DECEMBER 9.

ROYAL SOCIETY OF ARTS, at 8.—Domestic Metal Work of the 18th Century: W. A. Young.

THURSDAY, DECEMBER 10.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Electrical Conductivity of Echinoderm Eggs, and its Bearing on the Problems of Fertilisation and Artificial Parthenogenesis: J. Gray.—The Endemic Flora of Ceylon with Reference to Geographical Distribution and Evolution in General; Dr. J. C. Willis.

MATHEMATICAL SOCIETY, at 5.30.—Simultaneous Equations, Linear or Functional: E. H. Neville.—Integrals and Derivatives, with respect to a Function: W. H. Young.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Automatic Protective Switchgear for Alternating Current Systems: E. B. Wedmore.

FRIDAY, DECEMBER 11.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—The Geographical Distribution of *Purpura lapillus* (L.): Rev. A. H. Cooke.—The Non-Marine Mollusca of a Post-Pliocene Deposit at Apethorpe, Northants: A. S. Kennard and B. B. Woodward.—Monstrosities of Cypræa: L. St. G. Byne.—Monstrosities in *Littorina rudis*: J. E. Cooper.

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THURSDAY, DECEMBER 10, 1914.

RELATIVITY.

The Theory of Relativity. By Dr. L. Silberstein. Pp. viii+295. (London: Macmillan and Co., Ltd., 1914.) Price 10*s.* net.

THE appearance of a connected account of the Principle of Relativity in our own language will be welcomed by many as an opportunity of acquainting themselves in more detail with the ins and outs of a controversial subject. The note of controversy is, however, almost completely absent from this book. There is scarcely a reference to the longings of the physicist for an objective æther, save the sentence, "Lorentz had not the heart to abandon the æther which he confessedly 'cannot but regard as endowed with a certain degree of substantiality.'" The readiness to "abandon" well-worn concepts and old-established theory is becoming a marked feature of the thought of physicists to-day. We are witnessing at this moment a revolutionary movement in the 'quantum theory' which at times seems to forget entirely the classical electrical theory, and all the wealth of experimental evidence out of which it grew. In the same way the exponents of the principle of relativity have found delight in pouring contempt on the æther as the basis of electromagnetic influence, while in their turn the more conservative of physicists, failing to see how natural was the transition from Lorentz' theory of optical and electromagnetic phenomena in moving bodies to the novel point of view of Einstein, seized upon the somewhat artificial system of clocks by which the latter sought to make his meaning clear, and found in it a laughing-stock.

It is strange that there has been so much difficulty in making the fundamental point of view of this theory clear to those whose interests are experimental rather than theoretical. Many will read Dr. Silberstein's careful and detailed introduction to it, consider his illustrations, and follow his logic, and yet feel there is something lacking. The 'argument from need' for an æther is not dealt with. The reluctance that Lorentz had to abandon the æther remains. The seeker after a deeper understanding of the physical is apt to fight shy of a principle which cannot be expressed in terms of concepts to which he can give some 'degree of substantiality.' A systematic exposition of the principle of relativity necessarily consists very largely in the demonstration of invariant properties of certain mathematical relations. Hence it is almost bound to appear a little uninteresting to the experimentalist. Dr. Silberstein compresses the purely mathematical discussion, and judiciously separates it from the general and descriptive account as far as possible. He shows how many of the invariant relations fall simply and naturally into quaternionic form. But little is done to remove the unfortunate impression that relativity is a fad of the mathematician, and not a thing for the every-day physicist. It is to be feared that many will turn to this book full of hope, and come away from it feeling that the subject is barren for the future. For the universe is not compact of quaternions or matrices. As a physical principle, the principle of relativity needs to be placed in its relation to other great generalisations, such as the conservation of energy and momentum, and the status of the fundamental concepts of space and time in mathematical physics needs to be clearly realised.

The present book gives an adequate supply of material for meeting these needs; the account of the developments which led up to Einstein's work is useful and clear; but the reader will need imagination and sympathy if he is to find here an answer to the many difficulties which the subject raises.

PRACTICAL CHEMISTRY.

(1) *The Elements of Qualitative Chemical Analysis.* By Prof. Julius Stieglitz. Vol. i.; Fundamental Principles and their Application. Pp. xi+312. Vol. ii.: Laboratory Manual. Pp. viii+153. (London: G. Bell and Sons, Ltd., 1914.) Price 6*s.* net each volume.

(2) *Introduction to Modern Inorganic Chemistry.* By Dr. J. W. Mellor. Pp. xvi+684. (London: Longmans, Green and Co., 1914.) Price 4*s.* 6*d.*

(3) *Allen's Commercial Organic Analysis.* Vol. viii. Fourth edition. Entirely re-written. Edited by W. A. Davis and S. S. Sadtler. Pp. x+696. (London: J. and A. Churchill, 1914.) Price 21*s.* net.

(4) *Handbuch der Arbeitsmethoden in der anorganischen Chemie.* Herausgegeben von Dr. Arthur Stahler. Dritter Band. Erste Hälfte. Pp. x+692. (Leipzig: Veit and Co., 1913.) Price 22 marks.

(5) *Quantitative Analysis by Electrolysis.* By A. Classen. With the co-operation of H. Cloeren. Translated from the thoroughly revised fifth German edition by Prof. W. T. Hall. Pp. xiv+308. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1913.) Price 10*s.* 6*d.* net.

(6) *Anleitung zur Darstellung Phytochemischer*

Uebungspräparate. By Dr. D. H. Wester. Pp. xi+129. (Berlin: Julius Springer, 1913.) Price 3.60 marks.

(1) QUALITATIVE analysis still forms the beginning of all instruction in chemistry, but in its modern form it no longer takes the guise of the familiar tables, supported by the test-tube rack and the shelf of reagents. Indeed, at the hands of the more advanced apostles of physical chemistry it has been altered beyond all recognition, and it is from this point of view that we must criticise the new contribution of Prof. Stieglitz to the literature. The method of instruction advocated by him aims at developing the critical searching mind of the professional productive chemist. The students taking his course are supposed to have been prepared in general chemistry on physico-chemical lines.

In part i. of the new work the student is started off on fundamental principles, and he is involved at once in the consideration of osmotic pressure, theories of solution, ionisation, chemical and physical equilibria, as a preliminary to undertaking the systematic analysis described in part ii. For those few students who can stand it the treatment is admirable, but it demands teaching of the very highest class to make it at all successful, as well as very great concentration on the part of the student.

The second volume is entirely a laboratory manual devoted to the study of reactions and systematic analysis. The text, which is interleaved with blank pages, consists of a series of instructions of the usual type with the variation that the "ionic phraseology" is used throughout.

From the point of view of those who follow the new school the book is one of the best of its kind—whether it will help to produce another Hoffmann or Faraday, or what is as important, a Mond or a Muspratt, is more open to question.

(2) Dr. Mellor's "Modern Inorganic Chemistry" has already won a place on the shelves of most chemists, so that his new introduction, written from a more elementary point of view, should need no external recommendation. The author's statements as to what a student may expect from a general course of chemistry are worth quoting even at a risk of repetition, as too many of the modern text-books have already the opposite tendency. They are:—(1) Skill in observation and experiment; (2) memory and knowledge of relevant facts; (3) ability to reason and think in a logical, systematic way; (4) cultivation of the imagination; (5) development of a critical and impartial judgment.

The finished student with these attributes would not seek long for a lucrative position.

(3) The volume under notice completes the new edition of this well-known work, though we understand that a supplemental volume bringing the whole work up to date is in course of preparation. The articles on the analytical examination of the proteins are written by eleven authors whose names are sufficient guarantee of the completeness of the sections. It would be easy to quote small details where errors or omissions had been made, but it is fairer to comment on the vast mass of information which the volume contains and to praise the industry which has gone to its making, the more especially as such work is well known to be largely a labour of love. The new edition of Allen's work will more than maintain the reputation won by its forerunners.

(4) Dr. Stahler's work is an example of the modern omnibus type of German dictionary, full of every possible detail, and no doubt of the utmost value. The facts that it is very costly, so large as to make search in it a matter of difficulty, that it is published spasmodically in any sort of order, and contains a great amount of padding, all militate against it being found outside a few large university libraries. Furthermore, like so many recent German works, it tends to ignore much of the work done outside Germany, and so sacrifices any claim to completeness.

(5) It will be generally admitted that not the least of the advantages derived from the modern advances in electro-chemistry are the many valuable methods of analysis which have been based on them. In particular many of the methods are in use in those cases where speed is essential.

Prof. Classen's German text, which was published originally as long ago as 1882, is very widely known, and has passed through several editions. Prof. Hall has done a considerable service in bringing the English edition again up to date. The table of contents illustrates sufficiently how widely electro-analytical methods are applicable both to the more simple operations, such as the separation of metals from one another, and also to more special technical analysis, such as that of commercial copper, zinc, lead, and their ores. All the more recent new methods are included, and the apparatus required is fully described and figured.

(6) The danger of extreme specialisation has been emphasised often enough, but so exaggerated is this now becoming that we are offered from Germany a special course of phytochemical preparations picked out for the would-be botanist. A selection of organic compounds which are in some way connected with plants is made, and the manner of their preparation described in some

detail, so that the student can make them in the laboratory and gain an idea of their individual properties.

There will be no difference of opinion amongst teachers as to the futility of such a plan. The student can get no proper idea of chemistry as a subject, or of its theories and application. He will regard it merely as a series of manipulations, and his text-books as akin to cookery books.

At a time when the teaching of chemistry to medical students is steadily improving it is disconcerting to notice a tendency in the reverse direction in the case of biological students, which unhappily is not confined to the Continent.

MATHEMATICAL BOOKS: ELEMENTARY AND ADVANCED.

(1) *Arithmetic.* By H. Freeman. Pp. viii+231+xxxi. (London: G. Bell and Sons, Ltd., 1914.) Price 2*s*. 6*d*.

(2) *The School Algebra.* By A. G. Cracknell. Pp. viii+568+lxxvii. (London: University Tutorial Press, Ltd., 1914.) Price 5*s*.

(3) *Statics.* By R. C. Fawdry. Part i. Pp. vii+165. (London: G. Bell and Sons, Ltd., 1914.) Price 2*s*. 6*d*.

(4) *A First Schol Calculus.* By R. Wyke Bayliss. Pp. xii+288. (London: E. Arnold, n.d.) Price 4*s*. 6*d*.

(5) *A Treatise on Differential Equations.* By Prof. A. R. Forsyth. Fourth edition. Pp. xviii+584. (London: Macmillan and Co., Ltd., 1914.) Price 14*s*. net.

(6) *Linear Algebras.* By Prof. L. E. Dickson. Pp. viii+73. (Cambridge University Press, 1914.) Price 3*s*. net. Cambridge Tracts in Mathematics and Mathematical Physics, No. 16.

(7) *The Elements of Non-Euclidean Geometry.* By Dr. D. M. Y. Sommerville. Pp. xvi+274. (London: G. Bell and Sons, Ltd., 1914.) Price 5*s*.

(8) *A New Analysis of Plane Geometry, Finite and Differential, with numerous examples.* By A. W. H. Thompson. Pp. xvi+120. (Cambridge University Press, 1914.) Price 7*s*. net.

(1) THIS book consists mainly of examples, and there is said to be "just sufficient bookwork to be of use to a pupil when in difficulty." We do not think that, for example, any difficulty a pupil may feel about negative numbers can be dispelled by a complete absence of "bookwork" about them (p. 7).

(2) The aim of this book is to bring the teaching of elementary algebra into closer touch with "intelligible" calculations, and also to give a clear account of the elements of algebraic theory. The author warns us that "a rigorous logical account of the fundamental laws of algebra is very difficult, and would be quite out of place in a book of this description." Accordingly, we find, on p. 172, that "*the* negative unit" is defined as "*a* unit which cancels a positive unit" (the italics are ours). In this confusion between definite and indefinite articles, there seems to be some departure from the author's intention to give a clear account of things. The author seems to recognise that such things as the law of signs does present difficulties, but his treatment is not satisfactory. The book is not without merits.

(3) This pleasant little book shows the very healthy influence that the work of Mach has exerted on the teaching of mechanics. It deals with the subject on an experimental basis, and contains many examples, mostly numerical.

(4) This is an attempt to introduce the calculus by means of simple questions based upon matters familiar to the student either from his every-day experience or from his work in the laboratory. It is said to be "planned upon the latest educational theories," but this ought not to prejudice us against a very sound book which contains none of the subtlety that is required in higher walks of mathematics. For example, on p. 153, under the stimulating heading of "The Borderland of Discovery," the introduction of new functions by integration is treated apparently on the principle that any combination of symbols whatever must mean something. This is rather a natural supposition for most budding mathematicians to make, but it would be as well to warn them of possible dangers.

(5) The third edition of this well-known and solid work was published in 1903. This fourth edition is larger, but the general scope of the book is unaltered. Prof. Forsyth's object is to produce a working text-book, and the general theory is scarcely touched upon. Thus, such subjects as theorems of existence are noticed only by a reference to the author's "Theory of Differential Equations." There is an advantage, says the author, "even if only of conciseness," in assuming some results of the theory. Some parts of the book have been re-written, particularly the early part of the chapter on the hypergeometric series, and parts of the chapters on partial differential equations. A number of short additions has been made: on ordinary linear equations with some of their integrals of the type called "regular"; on total differential equations; and on partial equations. The only misprint—if, indeed, it is a misprint—that we have been able to find is a reference in the index to Abel on a page where algebraic functions are spoken of, and not Abel. It is perhaps almost inevitable that a text-book on

differential equations should not excite a learner's vivid interest unless it so departs from the logical order as to be historical. Often a modified logical order seems the easiest and most natural order. But the problem of education seems to be rather a problem of awakening interest, and not of choosing "natural" paths. Difficulties cease to matter if one's interest is aroused.

(6) Prof. Dickson's introduction to the general theory of linear algebras, including also non-associative algebras, shows in many places the influence of the German "Encyklopädie." The exposition of the main theorems of the general theory follows Cartan and, to some extent, Wedderburn, and is a most useful introduction to the subject.

(7) Here is an excellent text-book for all students of geometry. As seems to be always the case with this subject, the treatment is, to a great extent, historical, but the analytical treatment begun by Riemann occupies a rather minor position. A very welcome feature is that, throughout this book, Euclidean geometry is exhibited as a particular case of non-Euclidean geometry, and the apparent want of symmetry and the occasional failure of the principle of duality are explained. It seems rather confusing to assume tacitly, as the author does on p. 30, that through any point there are in hyperbolic geometry two, and only two, parallels to a given straight line.

(8) This book claims, rather magisterially, to be original. It seems to us more interesting than strikingly original. The equation of a line, $y=mx+c$, may be regarded as having the coordinates m and c. By using the word "measure" to denote a concept including both the distance of two points from one another, the perpendicular distance from a point to a line, and the angle between two lines, it is possible to state shortly what co-ordinate geometry does. This is the reduction of a set of joins and intersections of points and lines to functions of the measures of the elements. This idea is developed by the author and applied also in differential geometry.

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OUR BOOKSHELF.

Quain's Elements of Anatomy. Eleventh edition. Vol. ii., part ii., Splanchnology. By J. Symington. Pp. x+392. (London: Longmans, Green and Co., 1914.) Price 10*s.* 6*d.* net.

IN this further contribution to the eleventh edition of Quain's "Elements of Anatomy" Prof. Symington describes the following systems of the human body:—Digestive, Respiratory, and Urogenital. Two minor sections are devoted to the ductless glands and peritoneum, the latter being written by Dr. P. T. Crymble. During the eighteen years which have elapsed since the tenth edition appeared—under the joint editorship of Sir Edward Schäfer and Prof. Symington—anatomists, physiologists, and particularly surgeons have altered our conception of the splanchnology of the human body in many and important details. These changes are reflected in the text and illustrations of the new edition of "Quain."

No one is better qualified to edit this standard work on human anatomy than Prof. Symington. We feel, however, that in giving the Belfast school its full due, Prof. Symington has done less than justice to those who live and work outside the limits of Belfast. One example will suffice. About twelve years ago a series of observations were made by Keith, Barclay Smith, and T. R. Elliott, which served to show that the contents of the small and great intestine were separated, not by a mechanical valvular apparatus as was formerly supposed, but by a muscular mechanism, similar in the manner of its action to a sphincter. Sir William MacEwen and Dr. A. F. Hertz have demonstrated the existence of an ileo-cæcal sphincteric mechanism in the living human body, and emphasised its functional and clinical significance. Yet in the text of this edition no mention is made of these observations, and the erroneous and antiquated description of a mechanical valve is reproduced. This is the more surprising because the illustrations of the ileo-cæcal junction, reproduced from the former edition, bear out the non-mechanical nature of the ileo-cæcal orifice.

(1) *The Great Ball on which we Live.* Pp. 249. (2) *Our Good Slave Electricity.* Pp. 246. By C. R. Gibson. (London: Seeley, Service and Co., Ltd., 1915.) Price each volume, 3*s.* 6*d.*

MR. GIBSON has attempted with considerable success the solution of the old problem—how to interest children and at the same time instruct them. In the first volume he tells the story of the earth, and invites his readers to accompany him on imaginary visits to our planet before man's appearance on it. The fact that at one place a jelly-fish tells the story of what happened in the sea, and at another a worm records its experiences underground, will indicate the style of treatment adopted.

The second book describes in a similar simple manner some of the achievements of electrical science, and young readers will probably be led by these chapters to take up serious study later.

If it is possible to form sound elementary ideas of experimental and observational science merely by reading, it would be difficult to find more attractive introductions than Mr. Gibson has prepared.

Brown's Marine Electrician: for Sea-going Engineers. By A. E. and A. H. Larkman. Pp. xv+244. (Glasgow: James Brown and Son. Second edition, 1914.) Price 5*s.* net.

IN this book "the authors seek to give practical information on such matters as the installation, repair, and use of electric lighting, heating, and other appliances suitable for use in ships." Apparently the reader is expected to acquire that information from illustrations which seldom show more than the outside appearance of the apparatus, and often show nothing at all but a cast-iron case! There are some more detailed diagrams, but too many of them refer to machines or apparatus which could only now be purchased in the electrical equivalent of the old clothes shop.

The book will certainly enable the sea-going engineer to distinguish between a search-light and a telephone, or between a dynamo and a switch, but we fear he would be very much at sea when anything went wrong if his knowledge was not a great deal deeper than that in the book.

It may be the printer's fault that a very ordinary Welsh name is given as that of one of the celebrated builders of high-speed engines, and that Mr. Marconi's has been associated with his great rivals. But these errors sufficiently well typify much of the contents of the book.

David Robertson.

Die Insekten Mitteleuropas insbesondere Deutschlands. Edited by Prof. C. Schröder. Band iii. Hymenopteren (Dritter Teil) Die Gallwespen (Cynipidæ). By Prof. J. J. Kieffer. Die Blatt- und Holzwespen (Tenthredinoidea). By Dr. E. Enslin. Pp. xiii + 213 + viii plates. (Stuttgart: Franckh, 1914.) Price 7.20 marks.

The third part of the third volume of the "Insects of Central Europe," so ably edited by Prof. Chr. Schröder, of Berlin, contains an account of the gall-wasps (Cynipidæ) by Dr. J. J. Kieffer, and of the saw-flies and wood-wasps (Tenthredinidæ) by Dr. E. Enslin. In both cases the systematic description is preceded by an effective introduction dealing with structure, life-histories, and ecology. Thus we find a very clear account of the various theories of gall-formation by Cynipidæ and of parthenogenesis in Tenthredinidæ. The volume is very well illustrated, both as regards the text figures and the coloured plates.

Bartholomew's Orographical Map of Central Europe, showing Political Frontiers. Scale: 31·5 English miles to 1 in. Price 2*s.* 6*d.* net. *Bartholomew's War Map of Europe and the Mediterranean.* Scale: 86 miles to 1 in. Price 1*s.* net. (Edinburgh: John Bartholomew and Co., 1914.)

Nothing assists an intelligent appreciation of the details of military campaigns more than good maps of the areas concerned. The maps before us are excellent. The first enables the reader of war news to realise the intimate interdependence of strategy and land relief; and the second depicts boldly the present extent of the European territories of the nations at war. Both maps are produced in the workmanlike manner for which the Edinburgh Geographical Institute has long been well known.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

Soldiers as Anthropologists.

In Nature of December 3 (p. 383) there appeared a brief abstract of a paper communicated by Mr. Reginald A. Smith to the Royal Anthropological Institute on behalf of its author, Major E. R. Collins, D.S.O., now a wounded prisoner of war in Germany. The paper is not only an important contribution to our knowledge of the prehistoric stone implements of South Africa, but is evidence that a brave and capable soldier may, while helping to shape the history of his own time, give material assistance in unravelling the past history of the country through which he may be campaigning.

Major Collins collected the material for his paper while engaged on trenching operations during the late Boer war. These operations extended over a large part of South Africa—from Cape Colony to the Transvaal. The trenches were usually cut to a depth of 5 ft., and often crossed terrace deposits, which are presumably of Pleistocene age. It was whilst engaged on these operations that Major Collins made his collection of the stone industries of the ancient inhabitants of South Africa, keeping systematic records of the deposits in which the implements occurred, and the levels at which the various types were found. That Major Collins's interest in anthropology did not interfere with his military duties may be inferred from the fact that he earned the Distinguished Service Order.

Mr. Reginald Smith has directed my attention to an earlier instance of a soldier utilising military operations for the progress of anthropology. In the Journal of the Anthropological Institute for 1884 (vol. xiii., p. 163) there is a paper, also on South African implements, contributed by Major H. W. Feilden, which was described by the late Mr. Hyde Clarke, vice-president of the institute, as "remarkable for the circumstances under which the information was obtained—on the march, in the battlefield, and through the perils and vicissitudes of war." Major Feilden made his observations during the campaigns in Natal, 1881–82. I have little doubt that some of our French colleagues, amidst all the dangers and anxieties which attend the present war, will avail themselves of the opportunities presented by the extensive trenching operations in northern France to extend further our knowledge of prehistoric times.

I have headed this note "Soldiers as Anthropologists," but I may be pardoned if, at the present time, I direct attention to another side of the matter, "The Anthropologist as Soldier." In a letter I had lately the honour to receive from Prof. Manouvrier, secretary to the Society of Anthropology of Paris, I was grieved to learn that "Nous avons perdu en France un anthropologiste archéologue des plus estimés, M. Déchelette, capitaine de territoriale, tué dans une charge à la tête de sa Compagnie." M. Déchelette was author of a standard work, "Manuel d'Archéologie préhistorique Celtique et Gallo-Romaine," the third volume of which appeared during last year. M. Déchelette did not allow either his past or present services to science, his family ties, or his age—he was fifty-nine—to stand between him and what he considered his duty to his country. Although a great number of its members—including many of the most eminent anthropologists in Europe—are on active service—some have fallen, some wounded, and others decorated for bravery in the field—the Société d'Anthropologie still continues its meetings. I was able to inform Prof. Manouvrier that the sister society in London, in common with other English scientific societies, also continued its meetings, that many of its members—including the honorary secretary and assistant-secretary, had volunteered for active service, and that a member of the council (Major S. L. Cummins) had been decorated with the Legion of Honour.

"Pour moi," writes Prof. Manouvrier, in concluding his letter, "je ne puis plus qu'un vétéran—un ancien volontaire de 1870. Je fus ainsi un très obscur compagnon d'armes de notre aimé Lord Kitchener."

Royal College of Surgeons, ARTHUR KEITH.
Lincoln's Inn Fields, W.C.

A Central Thought of Vector Analysis as used in Physics.

VECTOR analysis is now recognised fully as furnishing standard modes of expression for many ranges of mathematical and physical thought; and meanwhile, the atmosphere of the physical thought especially is continually reacting upon the newer analytic method, and adapting it with preciser discrimination to the needs of actual use. Thus the dichotomous arrangement of quantities as scalar or vector has been supplemented by the tensor-triplet as a *tertium quid*, vectors are habitually grouped as free or localised, pseudo-scalars have been set off from pure scalars. Something has been done, too, through the influence of ascertained physical connections, toward unifying discrete formal results by appreciating real underlying articulation. Such advances as are made deserve immediate incorporation in the accepted text, as likely to render the methods more widely available; and the serving of that end has suggested presenting the notes that follow.

Most of the orthodox lines of development leave scalar product and vector product isolated from one another, each sharply differentiated by its own special definition. And an impression is then ordinarily felt that the novel characteristics of vector analysis in cutting through the rules of algebra centre upon the vector product. What there may be of exaggeration in this impression can be corrected by very simple and accessible considerations. First we may observe that an axial vector and a vector product are essentially two aspects of the same conception, the former being potentially resolvable into two factors determining an oriented area that is at the same time the geometrical basis of the vector product. But the projection of areas and their graphic representation by their measured normals are familiar elementary notions; while the assignment of "circulation" round the perimeter to an area, being necessary in order to complete the plan of conventional representation, must be expected to appear also in the equivalent vector product. In fact, the rule for sequence of the factors there and the change of sign upon reversal of that sequence are only assignment of circulation scarcely disguised. To establish the connection is to restore the emphasis of Grassmaun's thought where it may have been neglected.

At another point current procedure is apt to dislocate the vector product from its natural or original setting, and encourage a misleading effect of antithesis where there is in reality more nearly a complementary relation. When a scalar product and its corresponding vector product are introduced separately and held apart by exclusive stress upon their divergence of type, an instructive link uniting them is lost sight of or ignored. At their source they are linked in that completer combination of two vectors according to the fundamental idea of multiplication of which they are partial aspects. Again it is Grassmaun who more than hints at this very point of view, presented also in a somewhat different dress by the quaternion and the dyad. For purposes of elementary introduction the relation in question comes, perhaps, most clearly into prominence if the vector factors to be combined are from the outset of this particular development written each as a "semi-cartesian" trinomial, yielding thus nine terms for the presentation of the completed combination. On inspection three of these terms are obviously scalar; they constitute the "scalar product" (or expressed more fully the "scalar side of the product"). The remaining six terms are just as obviously to be accepted as vectors in their nature; together they constitute the "vector product" (or the complementary "vector side of the product"). These mutual complements make up the complete expression into which they enter, though they cannot coalesce, very much as a complex quantity contains a real term and a detachable imaginary term.

The value of the more inclusive statement is to be rated still higher in its justifiable extension to the combination of Hamilton's operator with a field-vector, which is also expressible formally as the expanded product of two trinomials, the nine terms of which, here too distinguishable as scalar and vector to unstrained interpretation, are presently grouped under the headings "divergence" and "curl." For the complete combination that might be written (∇V) is intended to place in our hands by its results a means of specifying with all reasonably attainable detail the local peculiarities of distribution for the field-vector. And here the usual partition of the specification into apparently quite disconnected divergence and curl seems plainly artificial at first sight, and becomes yet more so as we trace out the intimately complementary character of the two items in the description. It will always be helpful to emancipate ourselves from the formal constraints of our algebra, which here, for example, in a degree forbid the association of scalar and vector parts, and aim on the contrary, through the choice of orthogonal components, at a segregation at once complete and reduced to simplest terms. We remember with profit that one main office of the vector analysis is to do away with those mechanical features of algebra which contribute nothing or little to the progress of thought. FREDERICK SLATE.

University of California.

Science and National Needs.

IN a recent issue of NATURE (October 29, p. 222) the remark occurs:—

"In this hour of national emergency there is no time to be lost. We cannot all be soldiers, but we can all help, we men of science, in securing victory for the allied armies. Every day lost means the destruction of a number of our fellow-countrymen and of our allies, and the sooner we co-operate for the good of the nation the sooner will the war be over."

Acting upon the suggestion, and bearing in mind the manner in which the dew-ponds on Salisbury Plain suffered during the drought of 1911, I immediately offered my services to the War Office, to advise as to the digging of dew-ponds and the choice of sites for them.

I find that there is not now so great a necessity for them there as formerly, as water has been laid on to many of the camps, but should the necessity arise anywhere that camps are placed, the War Office has my offer before them.

I write this in order to encourage others to do what in them lies. EDWARD A. MARTIN.

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THE SUPPLY OF PITWOOD.

ATTENTION has already been directed in NATURE to the great diminution in the normal supply of pitwood since the beginning of the war. This tends at the moment to raise the cost of coal, and would, if continued, ultimately reduce the output. The official returns[1] show a great decrease in the import of pitwood from foreign countries, but this need cause no alarm so long as the command of the seas is retained. Ample supplies are available in Canada and Newfoundland, and a considerable amount of home-grown timber suitable for use in the mines can be felled during the coming winter.

FIG. 1.—A' Cruach before planting. Note the rocky face. From the Transactions of the Royal Scottish Arboricultural Society.

Timber is necessary in coal mines for supporting the roofs of galleries and main roads, for sleepers on the haulage lines, etc. Steel, concrete, and masonry are used in various ways as substitutes, but timber remains the cheapest and most easily handled material.

The great bulk of timber used in coal-mining consists of poles 2½ to 7 inches in diameter at the small end, which are cut into convenient lengths for use as pit props. Such poles are readily procured, either as thinnings or as the smaller-sized trees in woods which are clear felled, and are sold at a cheap rate, being of little value except for utilisation as pit props, firewood, or pulpwood. Both home-grown and foreign timber are used, but the former, of which no statistics are available, scarcely exceeds one-tenth of the total amount consumed. In 1912, a normal year, 260,000,000 tons of coal were raised in the United Kingdom, valued at 118,000,000*l.*, or 9*s.* 1*d.* per ton. During the same year the import from abroad of pit timber was 2,925,000 loads, equivalent to 117,000,000 cubic feet, valued at 3,660,000*l.* In other words, to raise each ton of coal about ½ cubic foot of foreign timber, costing 3⅓*d.* is required. The expenditure on pit props is about 3 per cent. of the price of coal. It is evident that a considerable increase in the price of pit timber could be borne before the cost of coal would rise to a ruinous figure.

There are two classes[2] of foreign pit-timber, the statistics of the import of which in 1912 were:—

	Loads	£
1. Spruce and common pine from Russia, Sweden, and Norway; nearly all from Baltic ports	1,170,000	... 2,580,000
2. Maritime pine from France, Portugal, and Spain ...	1,189,000	... 1,039,000

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[1] Import of pitwood from foreign countries, 193,002 loads in September, 1914, against 479,341 loads in September, 1913. The figures for the nine months ending September 30, 1914, are 1,920,000 loads; for the same period in 1913 as much as 2,585,459 loads

[2] A small quantity, 26,000 loads, from Germany and other countries is not included in the above figures.

As soon as war was declared, the supply from the Baltic practically ceased, as pit-timber was declared contraband by Germany, and its exportation prohibited by Russia. The supply from France, Portugal, and Spain, though hindered by scarcity of labour while mobilisation was going on in the Landes, appears to be now normal, as the price at Cardiff, which was 20*s*. per ton in July before the war, after rising to the panic figure of 35*s*. in August, dropped to 21*s*. on October 10. These pit-props of maritime pine are cheap in price, as the vessels which convey coal from Wales to Bordeaux, Lisbon, Oporto, etc., carry back the timber to Cardiff and Swansea as ballast at a nominal freight-charge, often as low as 4*s*. 6*d*. per ton. The Welsh collieries will probably continue to receive regular supplies from France, Spain, and Portugal, but these countries will have no surplus timber to send to other colliery districts in England and Scotland.

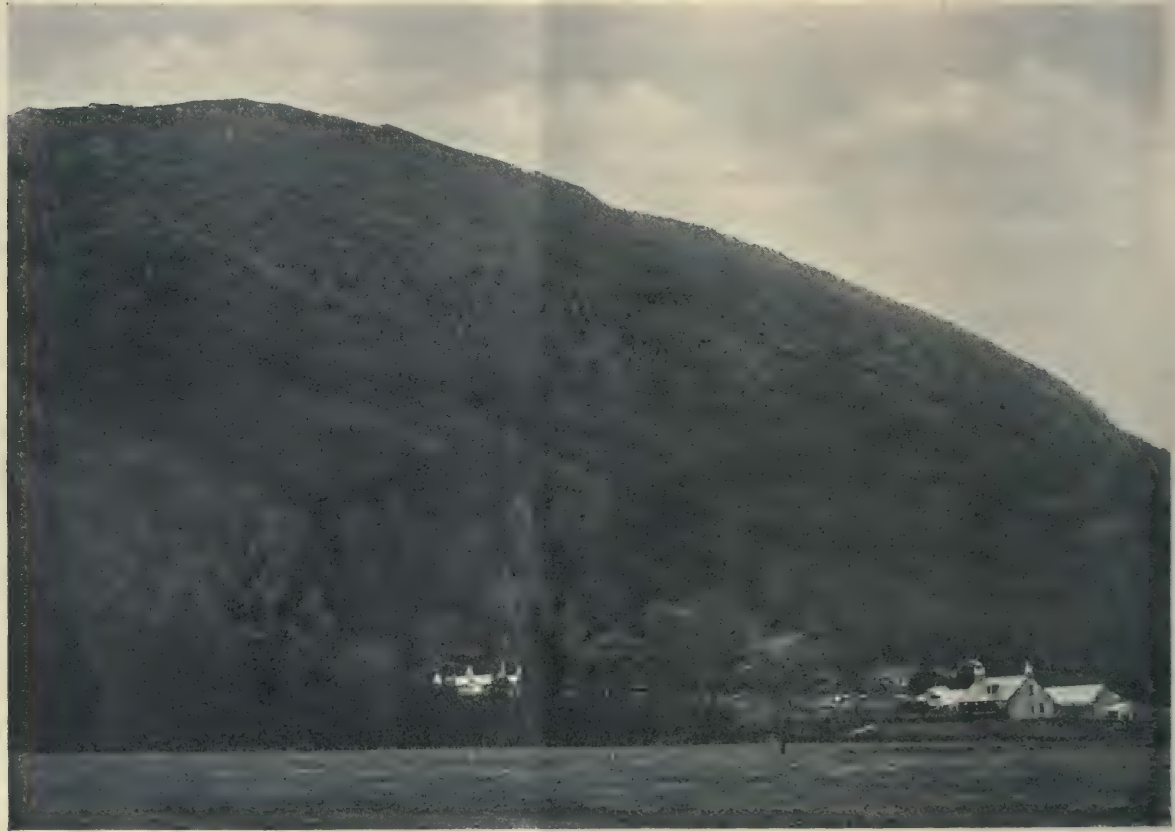

FIG. 2.—A' Cruach 32 years after planting with Douglas fir. (Altitude 54–1000 ft. above sea-level.) From the Transactions of the Royal Scottish Arboricultural Society.

It is well known that an abundance of timber suitable for pit-props is available in the vast forests of Canada and Newfoundland. Representatives of the Board of Trade, who were conferring on October 1 with the Dominion Minister of Trade at Ottawa, ascertained that the only difficulty is the question of price. It is not possible to obtain Canadian pit-props at as cheap a rate as the Baltic product, on account of the longer sea-voyage, higher cost of labour, etc. As soon as an equitable price is fixed,[3] we may expect adequate supplies of mining timber to arrive from Montreal, Quebec, Halifax, etc. In case of need, further supplies are doubtless available from British Columbia.

Home-grown mining timber consists chiefly of larch, spruce, and Scots pine, either grown in districts near the collieries, or obtained from the Highlands of Scotland and Ireland, the latter country sending last year about 50,000 tons of larch, a good deal of which is used in the pits of Lancashire. A small quantity of inferior timber, in the form of branch wood, coppice, etc., of broad-leaved species, like elm, sycamore, and beech, is also used from local sources; but it is disliked by miners, who prefer to handle coniferous poles, which are light in weight and smooth on the surface, besides being very strong. Oak, on account of its great strength and durability, is used in mines for special purposes, but in no great quantity.

In the present urgent necessity, the supply of native pit-timber can be greatly increased for one or two years at any rate. Once the price offered reaches a certain point it will be advisable for owners of coniferous plantations to execute moderate thinnings that will yield pit-props of useful sizes. The present time also affords an excellent opportunity for the clear-felling of unprofitable woods, that is, of all those which are not in a thriving state, or which are insufficiently stocked, or which are over-ripe, and no longer increasing in volume at an appreciable rate. A considerable area of coppice, which has been nearly worthless for some years past, owing to the constantly declining prices of all kinds of small timber, should also be cleared, and be converted into conifer plantations. All such clearances would provide a good deal of timber useful in the present crisis, which was formerly impossible to sell, owing to the abundant supply at a cheap price of the same kind of timber from the Baltic. After the trees are felled, re-planting with fast-growing conifers (as a general rule) should be proceeded with at once. All these operations, felling, planting, etc., would give rise to much employment of labour in country districts during the coming winter, and help to check the migration of the unemployed into the large cities.

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[3] To encourage shipment of pit-timber, vessels from Canada are now allowed by the Board of Trade, as an emergency regulation, to carry unrestricted deck-loads of timber.

Reasonable schemes of State afforestation have hitherto been regarded unfavourably by those in authority, but this view may change after the war is over. Meanwhile, during the present time of national danger, a great deal of useful work can be done by private owners of woodlands on the lines suggested above. There is little doubt that plantations, which can be made out of the proceeds of the sale of pit-timber besides increasing the employment of labour, will prove a safe investment.

What is possible in the way of afforestation in Scotland is the chief subject discussed in Transactions of the Royal Scottish Arboricultural Society (vol. xxviii., part 2), which has recently appeared. This part, besides some useful articles and notes on Douglas fir, Sitka spruce, acetone, etc., gives an account of a tour of inspection of the woods and afforestable lands of the Highlands, made during last July, to which foreign[4] and colonial representative foresters were invited. The splendid results obtained by modern methods of forestry in Perthshire, Deeside, and Strathspey were much admired. The enormous area of land suitable for afforestation was the main feature noticed in Inverness-shire and Argyllshire.

As an example of what can be done in a short period of years, the Benmore plantations on the Clyde are most remarkable. Here 2000 acres were planted thirty-four years ago, mostly on steep and rocky hill-sides, from sea-level to 1200 ft. altitude, the soil being a poor sandy peat covered with heather.

The species cultivated are mainly Douglas fir, larch, Thuya gigantea, Scots pine, and spruce; and the average volume per acre is about 3400 cubic feet, *i.e.*, an annual yield of 100 cubic feet of timber. One detached small plantation of Douglas fir and Thuya, situated at a low level, under 130 ft. altitude, was blown down in 1912, when it was thirty-five years old, and yielded the enormous volume of 7430 cubic feet of timber per acre, which was actually sold for 130*l.* The cost of planting, loss of grazing (5*s.* per acre), rates, taxes, expenses of management, with compound interest at 3 per cent. added, amounted to 61*l.*, so that this plantation gave a net profit of 69*l.* per acre at the end of thirty-five years. The owner of the estate, Mr. H. G. Younger, stated that the whole glen, if afforested in the same way, which could easily be done, would support an extra 1000 families by the employment that would necessarily arise. Fig. 1 shows the mountain of A'Cruach at Benmore with its bare rocky face before planting was done, and Fig. 2 shows it covered with forest trees. Both illustrations are from the Transactions of the Royal Scottish Arboricultural Society, and are here reproduced by the courtesy of the Society.

A. H.

WOOKEY HOLE.[1]

WOOKEY HOLE is situated in a narrow ravine on the south side of the Mendips, two miles from the cathedral city of Wells. Those familiar with the labours of the pioneers who discovered the presence of man in Pleistocene deposits of British caves need no introduction to this ravine in the Mendips, for the hyæna den, where Prof. Boyd Dawkins, the doyen of British "cave-hunters," commenced his labours fifty-five years ago, is situated on its eastern side, within stone-throw of the main series of caves which open on the ivy-covered crags at the northern or blind end of the ravine.

At the time when Prof. Boyd Dawkins (in partnership with the late Rev. T. Williamson) was commencing his early exploration of the hyæna den (1859), Pengelly and Falconer were bringing their exploration of the cave at Brixham to a close and were in a position to prove that the earlier discoveries made by the Rev. J. MacEnery at Kent's cavern and by Schmerling in the caves along the Meuse were true—namely, that man had been a contemporary of extinct animals such as the mammoth and woolly rhinoceros. Prof. Boyd Dawkins's explorations in the hyæna den at Wookey Hole clinched the matter; man had been living in England in the Pleistocene period. It is also worthy of remark that at the very time Prof. Boyd Dawkins was at work at Wookey Hole, Lartet was exposing, in the strata and hearths of the cave at Aurignac, human bones mingled with the charred remains of extinct animals and certain types of human implements—now recognised as characteristic of a period of Pleistocene culture.

In 1887, Mr. Henry Balch, the author of the work now under review, one to which artist, engraver, printer, and bookbinder have given of their best, began to make further explorations in the hyæna den, and afterwards transferred his labours to the main caverns which open at the head of the Wookey Hole ravine. In the vestibule or passage leading to the first of the three great caverns (see Fig. 1) he found a deposit on the floor amounting in thickness to nearly six feet. The main part of this work is an account of the exploration of this deposit. It is clear from the author's account that the vestibule or entrance had been used as a habitation by man during two periods. The more superficial or recent layers contained pottery and implements belonging to the period of the Roman occupation; the deeper strata were marked by objects belonging to a pre-Roman period—one which reaches back, in Mr. Balch's opinion, to about 400 B.C. The pottery, implements, ornaments, and objects of culture, found in the deeper strata are identical with those revealed by the investigations at Glastonbury. It is evident that the cave was used as a habitation when the neighbouring lake-village of Glastonbury was in existence.

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[4] Dr. P. E. Müller, the great authority on Forest Soils, was the delegate from Denmark. His views concerning the succession of soils and of species of trees in the Danish forests form the subject of an article in the Transactions, p. 241, which is of interest to plant ecologists as well as foresters.

[1] "Wookey Hole: Its Caves and Cave Dwellers." By H. E. Balch. Pp. xiv + 268. (London: Humphrey Milford, Oxford University Press, 1914.) Price 25*s.* net.

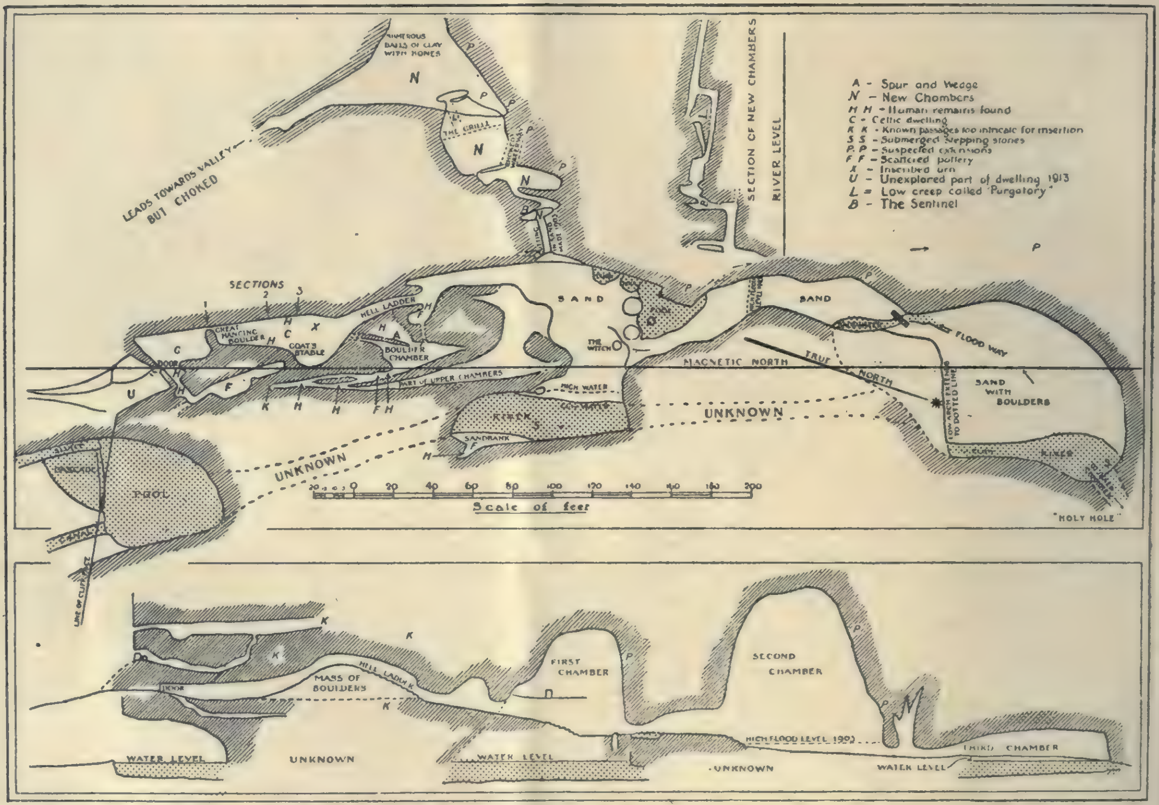
NUMEROUS BALLS OF CLAY WITH BONES
N
P
THE GRILL
L
LEADS TOWARDS VALLEY BUT CHOKED
SECTION OF NEW CHAMBERS
RIVER LEVEL
A - Spur and Wedge
N - New Chambers
H H - Human remains found
C - Celtic dwelling
K K - Known passages too intricate for insertion
S S - Submerged stepping stones
P. P - Suspected extensions
F F - Scattered pottery
X - Inscribed urn
U - Unexplored part of dwelling 1913
L = Low creep called "Purgatory"
B - The Sentinel
SECTIONS
1
2
3
GREAT HANGING BOULDER
C
H
X
GOATS STABLE
HELL LADDER
A
BOULDER CHAMBER
DOOR
U
F
PART OF UPPER CHAMBERS
K
H
F
SAND
THE WITCH
HIGH WATER
RIVER
SANDBANK
MAGNETIC NORTH
TRUE NORTH
FLOOD WAY
SAND WITH BOULDERS
UNKNOWN
CASCADE
POOL
CANAL
LINE OF CLIFF FACE
Scale of feet
20 0 20 40 60 80 100 120 140 160 180 200
"HOLY HOLE"
FIRST CHAMBER
SECOND CHAMBER
THIRD CHAMBER
MASS OF BOULDERS
HELL LADDER
HIGH FLOOD LEVEL 1909
WATER LEVEL
UNKNOWN

FIG. 1—Wookey Hole Cavern. Plan and Section by H. E. Balch and R. D. R. Troup, 1912. From "Wookey Hole: its Caves and Cave Dwellers."

Mr. Balch describes and figures in full detail all the traces left by these ancient pre-Roman inhabitants of Somerset. He has brought his imagination to bear on all the details and sought to reconstruct the home life of the cave-dwellers —ably seconded by the pencil and brush of Mr. John Hassall. He pictures the arrival of these cave-dwellers from Brittany, in order to explain the similarity of their cave pottery to that of the ancient Bretons. He elaborates a tragic short story of a goat-herd to explain the discovery of part of a human skeleton, the skulls of two goats, an earthenware pot, a tethering stake, and a deposit of goat manure in the strata and recesses of the cave floor (see Fig. 2).

Mr. Balch suspects the cave-dwellers of cannibalism (1) because stray human bones were found in the strata of the cave, mixed with animal bones, and (2) because some early writers have alleged that the ancient British were cannibals. None of the bones showed the least mark of human workmanship—of knife or of saw; the fractures which Mr. Balch figures are those which may be seen in human bones dug from modern graves—fractures produced by the grave digger's spade. If human bones are found scattered in the floor-strata of a British cave there is no need to suspect our ancestors of cannibalism. Nothing is better known than that Neolithic people used caves as sepulchres. We know, too, that rabbits and all sorts of animals which frequent caves, scatter the bones of skeletons embedded in the floor. Mr. Balch himself discovered a small cave in the heights above the Wookey Hole ravine; he relates how the human remains on the floor of that cave had been dismembered and spread by the animals frequenting the cave. No; Mr. Balch must bring more convincing evidence to convict the cave-dwellers of Wookey Hole of cannibalism.

Mr. Balch, with justice, dedicates his book to

Prof. Boyd Dawkins, who contributes an introductory chapter, in which he fights gallantly for opinions and conclusions put forward fifty years ago. In the opinion of the veteran geologist of Manchester we have not yet discovered a specimen of the people who lived in the caves of the Mendips during the Pleistocene period. The human skeleton discovered in Gough's cave at Cheddar he regards as an interment of the Neolithic period—whereas those who have investigated the evidence relating to the antiquity of the Cheddar man have formed an entirely opposite opinion—namely, that he represents a race which inhabited Somerset during Pleistocene time. Through the kindness of Prof. Fawcett of Bristol the writer of this note had an opportunity of examining two human skulls dug from the cave earth beneath the stalagmite of one of the Mendip caves. All the circumstances attending their discovery show that they are Pleistocene in age. What is more to the point is that they are exactly of the same form and show the same characteristics as the Cheddar skull. More interesting still, those ancient cave men are apparently of the same race as the early Neolithic people of England. Those who are following closely the progress of our knowledge of the ancient inhabitants of Britain expect much from the caves of the Mendips, and from hints dropped by Mr. Balch in this work, we have every reason to expect that these hopes will be realised.

A. KEITH.

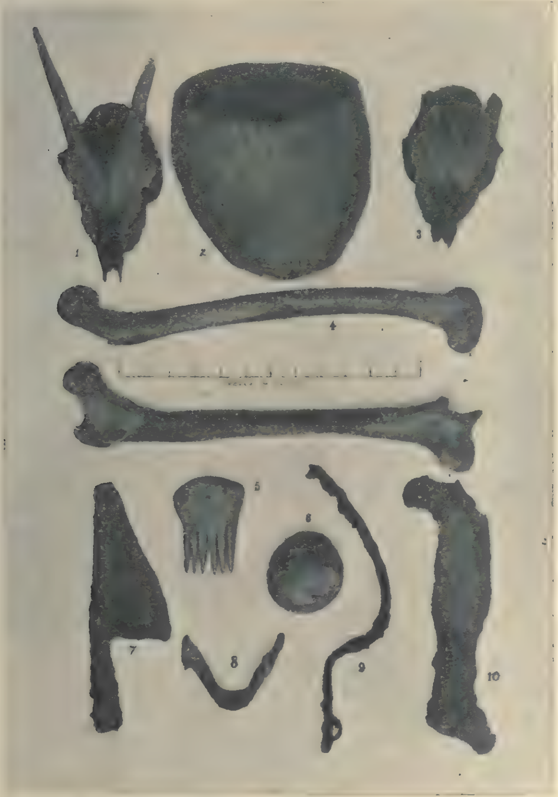

FIG. 2.—Relics of the Goat Head. From "Woo and Cave Dwellers."

NOTES.

DR. C. S. SHERRINGTON has been elected Fullerian professor of physiology at the Royal Institution for a term of three years, the appointment to date from January 13, 1915.

WE regret to see the announcement of the death, at eighty-nine years of age, of the Rev. Sir John F. Twisden, formerly professor of mathematics at the Staff College, and also for forty years one of the professional examiners in mechanics to the Department of Science and Art, and afterwards to the Board of Education.

IT is reported from Paris that Prof. A. Calmette, director of the Pasteur Institute at Lille, who resumed service at the beginning of the war in the capacity of Medical Inspector of Colonial Troops, is a prisoner at Munster, in Westphalia. Should any readers of NATURE have news of other men of science who are interned or prisoners on account of the war, perhaps they will send it to us for publication.

THE European war has unexpectedly checked scientific exploration in South America. Dr. W. C. Farabee, the leader of the University of Pennsylvania's expedition up the Amazon, has sent home word that he has had to cut short his journey owing to the fact that "the lack of funds, due to the uneasiness over the European war, made transportation difficult." The party had, however, already travelled about 4000 miles, and made some valuable anthropological collections.

THE eleventh award of the Reuben Harvey Memorial triennial prize will be made on July 1 next. The prize will be awarded to the writer of the best essay, on a subject to be selected by the candidate, showing original research in animal physiology or pathology, the essay to be illustrated by drawings or preparations. The competition is open to all students of the various recognised schools of medicine in Dublin, and to graduates or licentiates of the medical licensing bodies in Ireland of not more than three years' standing. The essays must be sent on or before June 1 next to the registrar of the Royal College of Physicians of Ireland, Dublin.

THE next meeting of the American Association for the Advancement of Science and of the affiliated scientific societies will be held in Philadelphia, and will begin on December 28. The retiring president, Dr. E. B. Wilson, of Columbia University, will introduce the president of the meeting, Dr. C. W. Eliot, of Harvard University, and will give the annual address on some aspects of progress in modern zoology. An interesting event of the meeting will be the first assembly of the newly established section of agriculture, which will meet on December 30. The address of the vice-president of the section, Dr. L. H. Bailey, late director of the College of Agriculture at Cornell University, will deal with "The Place of Research and of Publicity in the Forthcoming Country Life Development." A symposium on the general subject of "The Field of Rural Economics" has also been arranged.

THE following are among the lecture arrangements at the Royal Institution, before Easter:—Prof. C. V. Boys, a course of six experimentally illustrated lectures, adapted to juvenile auditory, on science in the home; Prof. W. J. Pope, two lectures on colour photography; Sir J. G. Frazer, two lectures on the belief in immortality among the Polynesians; Dr. H. G. Plimmer, three lectures on modern theories and methods in medicine; Dr. Chalmers Mitchell, three lectures on zoological studies: war and evolution; Dr. Aubrey Strahan, two lectures on London geology; Dr. R. T. Glazebrook, two lectures on aerial navigation—scientific principles; Sir J. J. Thomson, six lectures on recent researches on atoms and ions. The Friday evening meetings will commence on January 22, when Sir James Dewar will deliver a discourse on problems of hydrogen and the rare gases. Succeeding discourses will probably be given by Dr. Dugald Clerk, Prof. A. W. Crossley, Dr. W. S. Bruce, Prof. E. B. Poulton, Rev. A. L. Cortie, Sir Rickman John Godlee, Prof. G. H. Bryan, Sir J. J. Thomson, and other gentlemen.

THE death is announced, at fifty-seven years of age, of Dr. A. Celli, professor of hygiene in the University of Rome. The *British Medical Journal* gives the following account of his career and scientific work:—When still quite young Prof. Celli was appointed to the chair of hygiene at Palermo, from which, twelve months later, he was transferred to Rome. There he continued to work—teaching, investigating, and promoting social legislation—till last May. To his persevering efforts were largely due the sanitary improvements that have been made in the Campagna, and the organised campaign for the suppression of malaria. His scientific work covered a vast extent of ground, including research on the parasites which cause malaria, on cholera, on pellagra, on cerebro-spinal meningitis, on dysentery, on flies as transmitters of disease, on rabies, and many other subjects. He was an untiring worker in the cause of social reform through the spread of scientific knowledge.

THE death is reported, in his sixty-second year, of Dr. John Nisbet, Forestry Adviser to the Scottish Board of Agriculture. Dr. Nisbet was educated at the Edinburgh Institution and University, passing into the Indian Forest Service in 1875. He studied forestry at Munich, taking the degree of Doctor in National Economy. In Burma Nisbet proved himself a sound forester and a brilliant writer. He rose to the grade of Conservator of Forests, retiring in 1900. In 1903 he was decorated with the Kaiser-i-Hind gold medal for public service. His "Burma under British Rule," published in 1901, received high commendation. Dr. Nisbet spent his periods of furlough in studying British forestry and in making extensive tours in Continental woods. He thus proved a valuable coadjutor in the early 'nineties to Sir William Schlich in the campaign the latter inaugurated to arouse in these islands an interest in the forestry problem. Among the most important of Dr. Nisbet's publications of this period are "British Forest Trees" (1893), "Protection of Woodlands" (1893), "Essays on Sylviculture" (1893), "Studies in Forestry" (1894). After retiring from India Dr. Nisbet was appointed lecturer in forestry at the West of Scotland Agricultural College, relinquishing this post in 1912 when he was appointed to the Board of Agriculture. In these posts he devoted himself and his whole energies with an ardour which has not improbably shortened his life. He proved himself, with his wide and ripe experience, gained in many countries, a most valuable adviser and interesting lecturer, and his loss will be severely felt in Scotland by his Department, by the Scottish Arboricultural Society, the Transactions of which he edited at one time, and by many who sought his advice. His later publications included "The Forester" (1905), "Our Forests and Woodlands" (1908), and "The Elements of British Forestry" (1911).

THE death of Emeritus Prof. Campbell Fraser, of the University of Edinburgh, at the advanced age of ninety-five years, removes one who knew the city almost as Scott knew it. Dr. Fraser became professor of logic in the New College, Edinburgh, in 1846, and ten years later he succeeded Sir William Hamilton in the chair of logic and metaphysics in the University of Edinburgh. To the active duties of his chair he added very soon those of the dean of the faculty of arts, and continued to act as dean until his retirement from academic labours in 1891. In the early 'fifties he also edited the *North British Review*, and came into touch with many of the most distinguished essayists and philosophers of the day. He lectured in a simple, clear, unimpassioned style, which did not appeal strongly to the ordinary student, but to those who had philosophical tastes he proved an admirable guide, and retained their affection to the end. Some twenty of his students have occupied chairs of philosophy in Great Britain and the Colonies, and if we include professors in theological colleges the number may be substantially increased. His literary output was considerable, the editions of Locke and Berkeley being of especial value; and no scientific man aiming at a philosophic understanding of the principles of science can afford to neglect Berkeley. As Gifford lecturer in Edinburgh in 1894–5 Campbell Fraser developed a philosophy of theism, based on traditional Scottish lines, but worked out in the broad spirit of the nineteenth century. His interest in science was shown by his becoming, early in his professorial career, a fellow of the Royal Society of Edinburgh, serving as a member of council for a term of years. Long after his retirement he appeared with great regularity at the annual graduation functions of the University, a tall though slightly stooping figure, with lofty head and flowing beard, the typical calm philosopher.

WE regret to learn of the death of Dr. G. B. Guccia, whose work will always be regarded as one of the outstanding elements in the development of recent Italian mathematical science. Living in Palermo, where he was connected with the business of a printer and publisher, it occurred to Guccia in 1884 to start a local mathematical society, and to publish printed accounts of its proceedings. Thus sprang into existence the Circolo matematico di Palermo, with twenty-seven original members, which number steadily increased; the total in 1908 was 570. By that time the Circolo had completely lost its local character, 319 of the members being non-Italian in nationality. These included 68 from Germany, 41 from France, 14 British, 25 Austro-Hungarians, and 92 from the United States. In 1894 Dr. Guccia was elected professor of geometry at the University of Palermo, and he was also a member of the International Council on the bibliography of mathematics, besides being president of the Italian section. When the International Congress of Mathematicians met in Rome in 1908 a "Guccia medal" was offered for the best essay on the theory of algebraic gauche curves, or, failing that, for some contribution to our knowledge of algebraic surfaces or other varieties. The commissioners, consisting of M. Noether (Erlangen), H. Poincaré (Paris), and C. Segre, recorder (Turin), awarded this medal to Prof. Francesco Severi. While the Palermo Society differs from any similar English institution in the fact of having received frequent grants from the Minister of Public Instruction and from the municipality of Palermo—these grants amounting in many cases to nearly 30*l.* and 20*l.* per annum respectively, still larger subsidies have been given by the founder himself. That the local society initiated thirty years ago should have now risen to the status of an international mathematical society of the first rank is a fitting tribute to the energy and enterprise of Dr. Guccia.

THE editor and publisher of the *Animals' Friend* are to be heartily congratulated on the success of their efforts to provide pads for the withers of cavalry horses at the front. Testimony to the value of these pads is afforded in letters of thanks from four yeomanry officers at the front published in the December number. Equal credit is due to "Our Dumb Friends' League," as reported in the same issue, for their successful effort to raise a fund for the purpose of affording assistance to wounded horses on the field of battle.

ACCORDING to a report in the December number of *British Birds,* bird-marking, under the superintendence of the editor, has been attended with conspicuous success during the past season, one operator having distinguished himself by ringing no fewer than 2521 nestlings. It is true, indeed, that the total number of ringed birds was much more than a thousand short of that in 1913, but this is more than accounted for by the decision to discontinue marking black-headed gulls. The most noticeable case of the recapture of a marked bird is perhaps that of a Sandwich tern ringed in the Farne Islands in July, 1913, and taken on the Ivory Coast in February of the following year.

ACCORDING to an article by Miss D. I. Griffin, the director, in the December number of the *Museums Journal,* the Children's Museum at Boston, U.S.A., has proved a complete success, the daily average of visitors being about two hundred, while on Sundays the attendance has sometimes reached a thousand. Temporary exhibits supplement week by week the permanent collections, and lectures (sometimes taking the shape of a stroll in the grounds) and lantern-slides form part of the programme. Labels are considered an essential feature of the museum, those devoted in the nesting season to temporary exhibits indicating the materials of which nests are composed, the adaptations of these structures to their surroundings, etc. The advisability of labels in children's museums is, however, by no means universally admitted, for in a discussion on a children's room at the Salford Museum, reported in the same issue, two museum officials declared them to be unnecessary, and liable to weary juvenile visitors. It was also questioned whether the chamber at Salford has any right to its title, a strong point being made by one speaker to the effect that the height of exhibition-cases could not possibly be made to suit both adults and children.

THE latest issue of the Bulletin of Entomological Research (vol. v., part 2, 1914) contains, in addition to several valuable systematic papers, a discussion by Mr. R. W. Jack, the Government entomologist in South Rhodesia, on the relation between tsetse-flies and "big game" in that part of Africa. Reviewing the evidence, Mr. Jack is inclined to support the opinion that the tsetse either increases or decreases in numbers, as the large ungulates are allowed either to increase under protective administration, or are freely shot or driven away. The restricted distribution of the species of Glossina suggests that these insects are "very delicately poised in the balance of nature," so that a considerable reduction in the available food supply—such as would be brought about by the disappearance of "big game"—might retard the rate of multiplication; for there is a "great expenditure of substance of the female in the comparatively slow process of reproduction." Were this reduction carried far enough, the tsetse might be unable to maintain its racial survival.

IN the last number of the *Journal of Genetics* (vol. iv., No. 2, 1914) Dr. C. Dobell publishes an interesting "Commentary on the Genetics of the Ciliate Protozoa." Students who are not specialists in the Infusoria can gather from this summary how far the results obtained by Woodruff and other recent investigators have modified the conclusions drawn from the famous researches of Maupas. Dr. Dobell's general conclusions at the end of his commentary will stimulate thought and provoke controversy. He objects strongly to the application of the term "cell" to an infusorian, which he insists should be compared with a whole metazoan, as it is "non-cellular" rather than "unicellular." Study of the Ciliates has convinced him of "the formidable complexity of all biological problems as presented by the Protozoa. . . . No new light has been thrown on the great problems of organic evolution. . . . The facts so far determined could indeed be used with far greater force to support the doctrine of the fixity of species." Biological thought just at present seems deeply shadowed by an oppressive scepticism.

IN a paper on the geology of Bermuda (*Amer. Journ. Sci.,* vol. xxxviii., 1914, p. 189) Prof. L. V. Pirsson concludes that the island is an ancient lava-cone that has been converted into a platform by marine erosion, the oxidised products of decay being washed seaward as an accumulation over the unaltered lavas. The calcareous deposits added later to the platform go back to Lower Oligocene times. The igneous rocks are described in the same volume, p. 331.

IN the Proceedings of the Liverpool Geological Society, vol. xii (1914), p. 1, C. B. Travis provides an interesting account of the plains of denudation of various ages in Great Britain. Special attention is given to the Cainozoic peneplains of south-west England, and the author believes that the features that have been ascribed in this district to marine erosion result from submergence, subsequent to a general planing down of the surface by subaerial agents. The references to literature are valuable.

A SUMMARY of the weather has been given by the Meteorological Office for the autumn season as comprised in the weekly weather reports for the period of thirteen weeks ending November 28. The mean temperature for the period was generally in excess of the average, but the difference was not more than 0·8° in any district of the United Kingdom, and there was a very slight deficiency in the south-east and south-west of England. The rainfall was deficient over the entire kingdom, the greatest deficiency being 4·60 in. in the north of Scotland, and the least 0·67 in. in the Channel Islands. The largest absolute measurement was 10·70 in. in the north of Scotland and the least 5·42 in. in the east of England. In the Channel Islands 93 per cent. of the average rain fell and the next highest percentage was 85 in the north-west of England and 82 in the midland counties, which was followed by 81 in the south of Ireland and 80 per cent. in the south-east of England. The west of Scotland had the lowest percentage of the average, 63, which was followed by 65 per cent. in the north of Ireland and 67 per cent. in the north of Scotland. The rainy days were everywhere below the normal, the least number being forty in the midland counties, and the greatest fifty-nine in the north of Scotland. The duration of bright sunshine was mostly in excess of the normal; the greatest excess occurred in the south-east of England, where it amounted to about one-fifth of the average.

UNDER the title, "The Ice Storms of New England," Mr. C. F. Brooks has contributed to the Annals of the Astronomical Observatory of Harvard College (vol. lxxiii., 1914) a valuable paper on the theory and conditions of occurrence of the phenomenon known as "glazed frost," or coating of ice formed on trees and other objects by rain congealing as it falls, or by other causes. The data quoted refer more especially to occurrences at the Blue Hill Observatory, Mass. (formerly established by Prof. A. L. Rotch) during the years 1886–1914, together with records from a valley station at Readville and a few kite observations. The conditions which may produce ice storms are arranged in a tabular form; the combinations show that theoretically such storms are possible with the surface air temperature above 0° C., although no considerable storm under that condition was noted at Blue Hill. Several of the cases are carefully discussed, and the author states that a study of some of the details shows that storms may occur with a temperature as low as $-13°$ C.; that it may rain hard or lightly; that the wind may come from any direction; and that the temperature may rise, fall, or remain stationary. Ice storms may be much more local than snowstorms, and their prediction in New England is very uncertain, and, at the same time, scarcely necessary.

THE latest volume of the Proceedings of the Edinburgh Mathematical Society (vol. xxxii., session 1913–14) contains a variety of interesting papers (sixteen in all), among which may be noted one on integral equations by M. Pierre Humbert; one on attractions of spherical and ellipsoidal shells by Prof. A. Gray; notes by Messrs. Taylor and Marr upon an elegant geometrical theorem, apparently first discovered by Prof. F. Morley; and papers by Prof. Whittaker and Mr. A. W. Young on Mathieu's differential equation. Prof. Gibson contributes an appreciative notice of that brilliant geometrician, J. S. Mackay.

IN illustration of a paper on the uses of mathematics by Dr. Samuel G. Barton, in *Science* for November 13, the author has worked through the eleventh edition of the "Encyclopædia Britannica," and has compiled a list of the subjects which have required the use of the symbols of the infinitesimal calculus in their treatment. The result of this inquiry is remarkable. The list contains 104 headings, of which perhaps a quarter refer to pure mathematics. The remainder deal with almost every branch of physics, chemistry, engineering, and meteorology, and as the author remarks, the appearance of "clock" and "sky" and many other entries may surprise even mathematicians. The author invites notice of omissions. Curiously none of the entries quoted appear to cover the important applications of the calculus to modern aeronautical problems. Is this Dr. Barton's oversight, or is the encyclopædia itself defective? Had the author selected a lower branch of mathematics than the calculus, such as trigonometry, the list would have been far greater. It would be interesting to estimate the percentage of articles containing some algebraic formula or equation.

Science for November 20 reproduces the address delivered by Prof. Carl Barus to the American Mathematical Society on the occasion of the one hundred and fiftieth anniversary of Brown University. Under the title, "The Mathematician in Modern Physics," it deals with the changes in the fundamental ideas of physics which have taken place since the author's student days, when Weber's theory of electromagnetic action at a distance was still regarded as a wonderful achievement, although Maxwell's ideas were slowly displacing it. Attempts to extend Maxwell's equations to moving electrical systems started a new epoch, and Michelson's light observations led in turn to the Lorentz-FitzGerald hypothesis of the contraction of a body along its line of motion, and to Einstein's theory of relativity, to which the late Minkowski gave so elegant a mathematical form. In another field Boltzmann shed new light by his definition of entropy, Wien then discovered the "displacement law," and we now have Planck's atom of energy, which seems destined to play an important part in all future advance, while matter itself—the indestructible matter of Lavoisier—recedes into the background to consort with such shades as velocity and acceleration.

In a "Sketch of a Generalised Theory of Relativity and a Theory of Gravitation" (B. G. Teubner, 1913; pp. 38) Prof. Einstein, in collaboration with Dr. Grossmann, gives a preliminary account of their attempts to base the whole structure of theoretical physics upon the assumption of an exact proportionality between heavy and inert mass, and consequently upon what Einstein calls "the hypothesis of equivalence." The meaning of the latter is: an observer enclosed in a box cannot decide whether the box rests in a statical gravitational field or is endowed with accelerated motion in a space free of gravitation. This leads to the requirement of universal invariance of a quadratic form in dx, dy, dz, dt with variable coefficients (which determine the gravitational field), instead of the very simple Lorentz-invariant of the "ordinary theory of relativity." Electromagnetic phenomena become entangled with gravitation; constancy of light-velocity is given up, of course; the Maxwell-Lorentz equations for a vacuum assume a generalised and more complicated form. Similar investigations are to be found in Kottler's paper of 1912 (*Wien. Berichte*, vol. cxxi.). There are many other striking consequences of the new theory, which obviously cannot be entered upon here. The "physical part" of the paper is written by Einstein, the "mathematical" part by Grossmann. Their theory, apart from undesirable complications, is far from being complete, since, as the authors themselves confess, they have not been able to find the general group of substitutions for their gravitational equations. We may remark here that, fortunately, there is thus far no urgent need of such generalisations, especially as Nordström's theory of gravitation based upon the "old" principle of relativity satisfies all reasonable requirements.

The Journal of the Institution of Electrical Engineers for December 1 contains an account of some interesting experiments made at the National Physical Laboratory by Messrs. S. W. Melsom and H. C. Booth on the temperature rise in twin flexible wires such as are employed in ordinary electric light installations for pendant lamps with shades. It was found that, with lamps consuming 55 watts and upwards the temperature rise at the cord grip was in many cases 24° C. or more, that is to say, twice that allowed by the wiring rules of the institution, and high enough to destroy gradually the rubber insulation on the wire and to weaken the silk covering. This was due to heat from the lamp, and was irrespective of any heating of the wire itself due to the current passing. Similar observations were made in the case of flexible wires leading to electric irons, hot plates, etc. The temperature observations were in all cases made by means of minute thermo-junctions placed at the points tested. The results of the investigation emphasise the desirability of periodically renewing these flexible wires without waiting for them to show outward signs of deterioration.

OUR ASTRONOMICAL COLUMN.

Distribution of Elements in the Solar Atmosphere.—No. 88 of the Contributions from the Mount Wilson Observatory contains the results of an investigation on the distribution of the elements in the solar atmosphere as given by flash spectra, contributed by Mr. Charles E. St. John. The spectrum used in this research was that which was obtained by Prof. Mitchell during the 1905 eclipse, and the results of the reduction of this spectrum, which have already been published, are here employed as the basis of the statistical discussion here described. The general scheme in this research has been to form numerous groups of lines on a simple plan, each element being considered by itself, and the lines of like solar intensity assigned to it forming the ultimate group. The results of the investigation are considered in relation to the author's previous conclusions regarding the distribution of the elements as deduced from the radial motion in sunspots, and he draws a series of general conclusions founded on the salient facts shown by flash spectra and displacements in the penumbræ of sun-spots based upon mean values. These are too numerous to be given here, but the author points out that "these facts are all harmonised by the consideration that the vapours of the elements ascend in detectable amounts to different heights, that the lines of any one element originate at depths increasing with decrease of solar intensity, that the enhanced lines are higher than unenhanced lines of equal solar intensity, and that we see into the sun to greater depth at the red end of the spectrum than at the violet." A general summary states that "the resulting distribution shows that H_3 and K_3 lines of calcium are the lines of highest level, followed by the $H\alpha$ line of hydrogen, and that, in the main, the heavy and rare elements occur in detectable amounts only in the lower portions of the solar atmosphere."

Photographs of Halley's Comet and Comets of the Year 1911.—In the *Annalen der k.k. Universitäts-Sternwarte in Wien* (vol. xxiii., No. 1) Dr. Joseph Rheden publishes a valuable memoir containing details about the photographs which he secured of Halley's comet in 1910 and other comets in 1911. Several instruments (on one equatorial mounting) were employed, such as an objective of 325 mm. aperture and 3·4 m. focal length, a Voigtländer portrait anastigmat of *f*/4·5, with focal lengths of 450 or 225 mm., and, lastly, a Zeiss-Planar *f*/3·6 of 110 mm. focal length, and another of *f*/3·5 of 100 mm. focal length. The memoir contains a brief description of the details of each of the photographs taken and numerous excellently reproduced plates illustrate the general forms of the various comets photographed. Besides Halley's comet, those of Kiess (*b*), Brooks (*c*), Quénisset (*f*) and Beljawsky (*g*), are discussed. It is interesting to note that attempts were made with two different instruments to record the transit of Halley's comet across the solar disc on May 19, but the weather was not very favourable, and the results not of a satisfactory nature.

Strange Objects Transiting the Sun's Disc.—In scanning the solar surface observers have often remarked that they have seen bright objects passing across the sun's surface, and have concluded that they were meteors in the absence of any other plausible explanation. Attention may be directed to two interesting letters dealing with this subject which are communicated to the *Observatory* for November by Prof. Barnard and Mr. Denning. They put before the reader a large number of instances when such objects were observed, and decide conclusively that these daytime showers are not meteors. Mr. Denning in a series of conclusions, sums up the reasons why the objects seen were nothing like telescopic meteors, and these are as follows:—They require a longer focus than the sun; they did not move in parallel directions; their general direction agreed with the direction of the prevailing wind; they were objects of irregular shape and light filamentous material; their vagaries of motion while in sight were greatly dissimilar to that of true telescopic meteors seen at night; and, finally, on one occasion Mr. Denning followed them on several successive days and a change occurred in the directions. These showers, they state, are purely local terrestrial events. In most cases they are seeds or the down of various plants carried by the wind at high elevations. In some cases snowflakes are the cause of the phenomenon, whilst insect-swarms, gossamer-threads, etc., are sometimes observed. Prof. Barnard states that at certain seasons of the year they can be seen in abundance when the telescope is pointed within a few degrees of the sun, giving the greatest angle of reflection, and if moving slowly appear like minute stars.

STARS HAVING PECULIAR SPECTRA.—In Circular No. 184 of the Harvard College Observatory Prof. E. C. Pickering publishes an additional list of stars having spectra with bright lines or other peculiarities found by Miss Cannon since the publication of Circular 178, which contained a list of peculiar objects in the course of the work on the new Draper Catalogue. The first table in the new circular gives a list of fourteen stars, six of which are described as new variables. In Table II. a list of thirty-one stars having composite spectra, including twenty-four new double stars, is given, and this brings the number of stars with composite spectra found on the Harvard photographs up to 100. The stars in this table range from magnitude 5·32 to 10·6, and the class of spectrum of the brighter and fainter components, as they have been determined from the general appearance of the blended spectra, are given in each case. In both tables the stars are arranged in order of Right Ascension, with the corresponding Durchmusterung numbers.

EFFECTS OF THE WAR ON SCIENTIFIC UNDERTAKINGS.

SEVERAL international or otherwise co-operative investigations of a scientific kind which were in progress at the opening of the war have necessarily been affected by the naval and military operations and the limitation of usual channels of communication. It is not opportune to state the position of some of these undertakings at the present moment, but various negotiations are proceeding, and it is hoped that a means will be found of carrying on work already well begun. The incalculable loss which scientific research must bear in the suspension of the international fishery investigations was referred to in an article in NATURE of October 22 (p. 201). Reference has also been made (NATURE, October 15, p. 183) to the need for a central bureau for the distribution of astronomical telegrams, as was done before the war by the Zentralstelle at Kiel. A few weeks after that note appeared Prof. Elis Strömgren, director of the University Observatory at Copenhagen, announced that by an agreement made between Prof. Kobold, of Kiel, as publisher of the *Astronomische Nachrichten*, and himself, the management of the Zentralstelle für astronomische Telegramme during the present war has been passed over to Prof. Strömgren. Consequently, all communications for the Zentralstelle should be addressed to him until further notice at the Observatory, Copenhagen.

The work of the Tropical Diseases Bureau in London has diminished since the outbreak of the war owing to the non-receipt of French and German journals; for the bureau exists primarily for the collection of information, chiefly from medical journals, on the diseases of tropical and subtropical climates, and its collation and dissemination within the pages of a journal, the *Tropical Diseases Bulletin*. There is little doubt that such investigations are being hampered in Africa by operations of war, and that they will be seriously interfered with in the future owing to lack of funds now derived both from the home Government and the tropical dependencies of Great Britain.

As to the future of the International Catalogue of Scientific Literature, the report of the council of the Royal Society states that the responsibilities of the society in relation to this undertaking have been a source of anxious consideration since the outbreak of the war. Apart from the question of continuance, the society is faced with serious liabilities in respect of this undertaking as it stands at the present moment. Should the annual amount of the subscriptions from Germany, Austria, Hungary, Belgium, and Poland not be available, as seems certain, at any rate until after the close of the war, this would mean an annual loss of about 1060*l.* in income in respect of each issue, or a total loss of about 4000*l.* on the issues of 1911, 1912, and 1913, after taking into account reduction of expenditure and in sales of trade copies and back numbers. This loss will fall, at any rate in the first instance, on the Royal Society.

Daily Weather Maps.—The Quarterly Journal of the Royal Meteorological Society (October, 1914) prints the subjoined note on the effect of the war on the issue of daily weather maps:—The sudden outbreak of war has a very marked effect upon the compilation and publication of the various daily weather maps. The *Daily Weather Report* issued by the Meteorological Office contained the usual information until July 31, but after that date some of the observations began to be missing, while from August 6 no data have been received from central Europe, and the wireless reports from the Atlantic were altogether discontinued. For several weeks the reports from Scandinavia and Spitsbergen were missing, but these were resumed in September, though reports from Iceland are still absent. The difficulties of preparing the usual forecasts and storm-warnings have consequently been much increased. The publication of the daily synoptic weather maps of Europe, the North Atlantic, and a large portion of North America, which has formed part of the *Weekly Weather Report*, has been suspended from August 2, until the necessary data have been received.

It has been the practice of the *Times* newspaper since 1876 to print each day the previous 6 p.m. weather map. This was continued until August 4, but after that date no further map appeared—no doubt owing to all the available space in the newspaper being urgently required for war information. For the same reason the table of observations from health resorts was discontinued from August 3.

On August 6 the Chief of the U.S. Weather Bureau announced that "owing to the state of war involving the great nations of Europe, the meteorological observations from regions in Europe and Asia, heretofore employed by the Weather Bureau in the construction of its weather map of the northern hemisphere, are no longer received, and the issue of this map will be suspended from this date until such time as the reports can be resumed."

Investigations of the Upper Air.—The effect of the war upon investigations of the upper air so far has only been indirect in the British Isles, but several independent causes have led to the fact that the present year has not been as fruitful of results as previous years, and the difficulty of getting rubber balloons of really good quality has been greatly intensified by the war. During both 1912 and 1913 between fifty and sixty satisfactory balloon ascents were obtained, but the average maximum height in 1913 showed a distinct falling off compared with previous years. This was due to the balloons, of which the quality and workmanship are of the utmost importance. During the present year, although fresh sources of supply have been tried, the quality of the balloons has still further deteriorated, with the result that in many cases a premature bursting of the balloon has occurred and a maximum height of some five only instead of some fifteen kilometres has been attained. Since the details of the ascents have remained the same, the poor heights reached must be due to defective balloons.

There is an old proverb that misfortunes never come singly. The ascents at Manchester have ceased since the beginning of this year, and a run of persistent ill-luck in the finding and return of the instruments has been experienced; also the station of the Meteorological Office at Pyrton Hill, Watlington, ceased to be available in the spring. The present station is at Benson, about six miles W.S.W. of Pyrton Hill, a place equally suitable, but the compulsory removal of the station dislocated the regular routine work of the investigation during the first half of the year. From these various causes the number of successful balloon ascents this year in the British Isles can scarcely reach twenty-five, since the war has, for the time being, cut off the supply of balloons, and the very poor returns from the first half of the year cannot be made up by an extra number of ascents in the latter part.

It has been an unsatisfactory state of affairs that balloons should have been obtained from foreign firms, but cheaper and better balloons were so obtainable. It is hoped that arrangements may shortly be made for the supply from an English firm.

There is another way in which the investigation may be influenced by the war. In England compressed hydrogen can be obtained cheaply and conveniently in steel cylinders, but in some of our colonies these cylinders cannot be obtained. Failing this source of supply hydrogen is most easily produced from calcium hydride, the free lift of the hydrogen in air being equal to the weight of hydride used. Apparently the calcium hydride can only be obtained in Germany.

There is no information about what is occurring on the Continent. The international days are fixed until the end of the year, but after December, if ascents continue in Germany and Austria, it does not seem likely that we shall know the dates. Also the meeting of the International Committee which was to have been held in England next year can scarcely now take place.

In the investigation of the upper air the value of the individual observations is decidedly increased by a well-planned system of co-operation, but happily there are many problems which may be attacked without such co-operation, and we may hope that the work may go on with equal vigour as in the past, excepting that the necessary funds are not likely to be increased by the heavy expenses due to the war.

International Seismological Association.—The fifth meeting of the International Seismological Association was to have been held early last September at Petrograd, under the presidency of Prince Galitzin. Soon after war was declared, it was announced that the meeting was postponed, and, indeed, with the president a Russian, the secretary a Hungarian, and a committee including Germans, Englishmen and Japanese, no other result could be expected. The formal meeting of the association once every two or three years is not, however, the most useful work carried out under its auspices. The permanent committee of the association, with its headquarters at Strassburg, was engaged in collecting materials that could not fail to be of the greatest service. The compilation of the annual catalogues of perceptible earthquakes and of those registered at distant stations would alone justify the existence of the Association. To all this useful work, there must for the present be an end, and, even if the threads of the organisation are ultimately resumed, there will be a long delay in the issue of the next catalogues, and there will be many imperfections in the lists of perceptible shocks. In the registers of seismological observatories, the effect of the war will probably be less serious, for the network of stations established in the British Colonies and in allied and neutral countries is practically world-wide. The late Prof. Milne's decision to maintain the organisation which he created outside the control of the International Association is thus likely to have most beneficial results.

THE NATURAL HISTORY MUSEUM IN THEORY AND PRACTICE.[1]

DR. GUSTAVE GILSON, director of the Royal Belgian Museum of Natural History, has recently given to the scientific world his views on the general theory of a natural history museum in a magnificent quarto volume. The following is a brief abstract of his conclusions.

A universal museum being obviously impracticable, a regional museum is all that can be attempted, and the "region" must be limited according to circumstances. The collections of the museum must be acquired by systematic observations conducted by one or more officials (*chefs d'exploration*) specially trained for this particular work, and the exploration must include the acquisition not merely of individual specimens, but also of such material, drawings, plans, photographs, and records as are needed to give a full account of the environment. "The museum ought only to accept with suspicion a specimen that has not been collected by its own officials and furnished with data written down at the moment of its discovery."

The museum is not primarily an institution for the dissemination of scientific information among the populace, but a progressve institution dedicated to the advancement of knowledge, free from all pedagogic trammels and from every preoccupation alien to the investigation of nature, and thus playing an important part in the humanitarian mission of the development of natural history: "le musée renseigne, mais n'enseigne pas." Nevertheless, the museum may without being false to its ideals, expound to the people many of the results of its work, and become a valuable teacher in a line, and by methods different from those of the schoolmaster.

The regional museum must preserve collections on a generous scale, but these must be properly kept in suitable storehouses (*conservatoires*) under the constant supervision of trained curators (*conservateurs*). Dr. Gilson makes some strong remarks on the failure of many museums to take due care of their treasures. Besides the main collections there should be others, such as the "comparative" department, containing examples of similar objects from other places for study in connection with those of the region. These specimens may, of course, be acquired by gift or purchase. There should also be a public collection of examples judiciously selected; "here everything useless is harmful." Every object must be accompanied by an explanation setting forth its most interesting characteristics, and addressed, not to the unlettered, but to the man of education, who is not a specialist. "Exhibition without explanation is vain and profitless, and causes a justifiable feeling of irritation in every serious intelligent visitor." The colonial museum is another institution which may form a suitable annexe to the regional museum, and should be the result of, and an incentive to, the carrying out of the principle that "exploration should precede exploitation," and, as the author aptly remarks, "the more thoroughly and scientifically the former is done the more profitable will be the latter."

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[1] "Le Musée d'Histoire Naturelle Moderne—sa mission, son organisation, ses droits." Extrait des Memoires du Musée royal d'Histoire naturelle de Belgique. By G. Gilson. Pp. xii+256. (Bruxelles: l'Académie Royale de Belgique, 1914.)

The relations, which should exist between the metropolitan museum and local museums are thus defined. "Certain species represented by only one specimen should be sent to the central museum, in view of the paramount necessity of centralisation. The central museum should, however, only receive these on deposit, and should carefully indicate that they are the property of the local museum. Furthermore, a cast or reproduction of such specimens should be placed in the latter with the label, 'The original is deposited in the national museum.'"

The regional museum must of necessity be a State institution, but the relations of the museum with the administrative departments of the State should be as simple and restricted as possible. The actual work of the museum should be controlled by an individual not a committee. "Under the autonomy of a personal head the institution utilises the powers of its direction to the full. If mistakes are made they are temporary; the error is in the personality which is short-lived. On the other hand, under the rule of a committee the work, impersonal in its nature, will be mediocre and sluggish, and the institution will vegetate exposed to the gravest perils; the error is perpetual because it is inherent in the system."

The remainder of the volume is devoted to an account of the Royal Belgian Museum of Natural History at Brussels, its origin, present condition, and future. Its history has been one not unusual in the case of similar institutions: progress impeded by official ignorance, coupled with apathy or opposition; the situation improved on the advent of a strong and enlightened personality who knew how to secure more generous treatment. At present the building consists of an old centre and a new south wing. It was proposed to add a similar north wing and a frontage parallel with the old building, but in present circumstances there does not seem much likelihood of these additions being carried out in the near future.

There are numerous well-printed illustrations, which represent a great variety of specimens and all departments of museum work, and it is a singular fact that, though they bear very directly on the text, they are scarcely ever referred to in it.

Royal Belgian Museum of Natural History, Brussels. The portion to the right is the old building; to the left is the new south wing; a north wing parallel to it was contemplated, as well as a new central connecting member parallel with the old building on the side remote from the spectator.

BACTERIAL DISEASES OF PLANTS.[1]

THE third volume of Dr. E. F. Smith's work on "Bacteria in Relation to Plant Diseases" deals exclusively with "vascular diseases"—that is, those in which the causal organism advances along the vascular tissues of the plant, completely blocking up the zylem vessels. When compared with the account by Russell under the same title, written in 1892, the present work shows markedly the immense progress made since that date in this branch of botanical study. It is a compilation representing indefatigable labour, and forms, with the preceding volumes, a comprehensive summary of all that is known under the head of bacterial diseases of plants. A feature of the work is the care taken to collect a complete biblography, and the author's extraordinarily wide knowledge of the subject and the extent of his own observations and research render his critical review of all investigations bearing upon the etiology of the disease of extreme value to other workers in this field. Moreover, the full abstracting of original papers, which are brought quite up to date, and lengthy excerpts concerning methods, technique, and results, fulfil the purpose of enabling the reader to form his own conclusions and emphasise the essential character of the publication as a book of reference.

Each disease described is treated in an exhaustive manner, the same plan having been followed throughout the series. The geographical distribution, history, signs of disease, the etiology and morbid anatomy are all fully considered, as well as the morphological and cultural characters of the parasite, to which great attention is given as a means of identification of the specific organism. A discussion of treatment is usefully included, and a general computation of pecuniary losses is attempted.

The present volume deals almost entirely with diseases affecting tropical or subtropical plants, such as the sugar-cane, banana, sweet-corn, etc., which are of no economic importance in this country. If, however, the cultivation of tobacco is to have any great development in Great Britain, a reference to these pages is indispensable as a guide to the destructive attacks to which this crop is subject, and the conditions which influence its successful growth. It seems also to be substantially proved by the author's own examinations and the weight of evidence which he has been able to accumulate, that the various forms of tobacco wilt, including those described by the Dutch and Japanese writers, are due to the same organism, *Bacterium solanacearum*, Smith, which causes the well-known rot of potatoes, tomatoes, and other solanaceous plants. This parasitic disease of tobacco has been known for the last twenty-five years in Japan, and the damage caused is widespread in all countries where tobacco is cultivated; the loss has often been enormous, and many planters have been driven to harvest their crop while unripe and half-grown, in order to save some portion of it.

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[1] "Bacteria in Relation to Plant Diseases." By Dr. E. F. Smith. Vol. iii., Vascular Diseases (continued). (Carnegie Institution of Washington, 1914.)

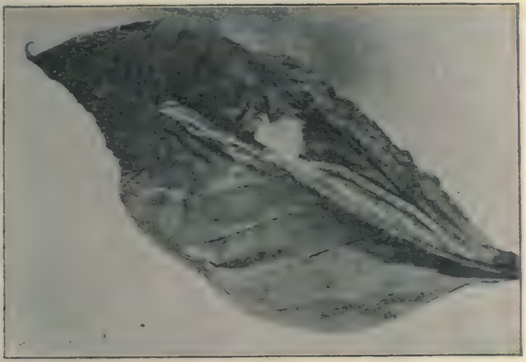

FIG. 1.—Tobacco-leaf from the hothouse, showing the typical red-brown shrivelled spots of the Granville tobacco wilt. The remainder of the leaf was green. *Bacterium solanacearum* abundant in vascular system of the midrib and in many side veins. Plant inoculated in stem, by needle-pricks, on September 23, 1905, using a pure culture of the North Carolina tobacco organism. Photographed February 20, 1906.

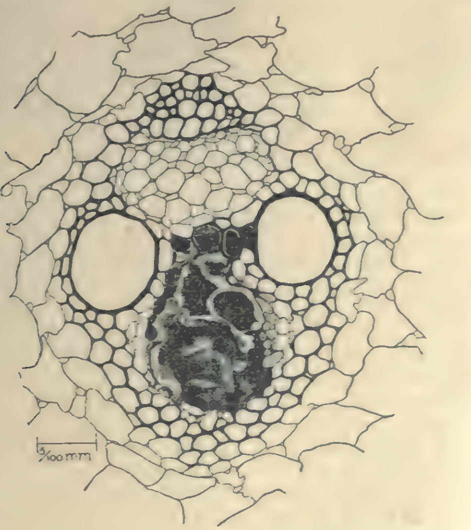

FIG. 2.—*Bacterium vascularum* in stem of sugar-cane received in 1902 from New South Wales. The figure represents a bundle in cross-section. The ground tissue, endodermal sheath, and phloem are still free, also a part of the xylem, including the two big pitted vessels. Sectioned from paraffin and stained with Flemming's triple stain, the contrast being not exaggerated.

The specific communicable disease of the sugar-cane, caused by a one-flagellate schizomycete, *B. vascularum*, Cobb, is, so far as is known, confined to this one host plant. It is responsible for a considerable reduction of sugar-content, and is apt to give trouble in the sugar factory, gumming the machinery, and interfering with proper clarification and crystallisation. The disease is most prevalent in the southern hemisphere, and it is satisfactory to learn that it has not been reported from the British West Indies or Porto Rico. It is, however, specially liable to be transmitted in cane cuttings, and planters in these islands are warned to be careful to guard against its introduction. The question of the origin and nature of the "gum," which is such a typical feature accompanying vascular bacterial diseases, is extremely interesting, and it is disappointing to find that nothing has been done on this point since Greig-Smith's work in 1904. His researches, undertaken upon the lines of qualitative chemistry, are entirely confirmatory of the bacterial origin of the "gummosis," as he concludes from tests of the chemical reactions that the "gum" and the bacterial slime from pure cultures on agar are identical. Apparently the mucilaginous substance blocking up the vessels is a bacterial zooglea, but its exact composition has not yet been determined, and remains one of the many unsolved problems of biochemistry. It would seem that these plant-gums are derived by the bacteria from the saccharine contents of the cell-sap, and are clearly not a degeneration product of the cell-wall, as was formerly supposed.

The book is profusely illustrated with excellent photographs and drawings showing all stages of the diseases cited and innumerable inoculation experiments.

M. C. P.

ZOOLOGY AT THE BRITISH ASSOCIATION.

SECTION D held its meetings in the lecture theatres of the Universities of Melbourne and Sydney, and presented a full and varied series of papers. It will be noticed from the subjoined summary that about one-half the time of the section was devoted to the consideration of researches on Australian material.

Recent Work in Antarctica.

A discussion on the past and present relations of Antarctica was arranged by Section D, in conjunction with the Sections of Geology, Botany, and Geography. An account of the contributions of the geologists and geographers to this discussion appeared in NATURE of October 19 (p. 241), so that it is only necessary to refer here to the observations made by Mr. Hedley and Prof. Seward on the biological relations of Antarctica.

Mr. C. Hedley stated that naturalists have deduced the age, climate, contour, fauna, and flora of Tertiary Antarctica from the nature of Antarctic refugees now living in southern lands. For instance—(1) the monotremes, once perhaps numerous, are represented by two widely different types which survive in Australia, Tasmania, and Papua; the bones of other monotremes occur in South American deposits; (2) the Thylacines are recent in Tasmania, and fossil in South America and Australia. Either we must consider that these groups arose independently in each hemisphere, or that they spread from the one to the other. In the latter case a south polar land offered the most direct path. The simplest explanation of the distribution of marsupials, past and present, is that they originated n South America, spread by way of Archihelenis to western Europe, by way of the West Indies to North America, and by way of Antarctica to Australasia. Turning to the Amphibia, Mr. Hedley pointed out that the families Hylidæ and Cystignathidæ have their chief seat in South America, and both families extend to Australasia, where they are best developed in the south-east and gradually vanish before reaching the Moluccas. In these cases also the most direct route between the two centres lies across Antarctica, and by cumulative evidence from plants and animals of many and varied kinds the conclusion is reached that this was the way they went.

Prof. Seward gave a brief account of some of the fossil plants collected by members of Captain Scott's second expedition, with special reference to Dr. Wilson's discovery of Glossopteris in 85° S. Fragments of well-preserved leaves of *Glossopteris indica* found in the rocks of Buckley Island, a nunatak on the Beardmore Glacier, afford important evidence, both as to the age of the Beacon Sandstone formation and as to a former connection between Antarctica and Gondwana Land. The geological distribution of Glossopteris in other parts of the world suggests that the strata of the Buckley nunatak must be assigned to the Permo-Carboniferous period. A large piece of wood obtained by Mr. Priestley from a sandstone boulder on the Priestley Glacier in 74° S. proved to be a gymnospermous stem of considerable botanical interest; the wood shows well-marked rings of growth and exhibits Araucarian characteristics, but in view of certain peculiar features has been referred to a new genus—Antarcticoxylon. Associated with this was found a winged pollen-grain, described as Pityosporites, which bears a striking resemblance to the pollen of recent Abietineæ. In conclusion, Prof. Seward referred to the bearing of these important discoveries on climatic considerations, and pointed out that while there is clear evidence of a considerable change in climatic conditions since the period when Glossopteris flourished on the Antarctic continent, there is no adequate reason to assume any change in the position of the earth's axis. Meagre as it is, the material collected by the polar party calls up a picture of an Antarctic land on which it is reasonable to believe were evolved the elements of a new flora that spread in diverging lines over a Palæozoic continent, the *disjuncta membra* of which have long been added to other land-masses where are preserved both the relics of the southern flora and of that which had its birth in the north.

Plankton.

Prof. Herdman gave an account of some recent plankton investigations in European seas (especially in the Irish Sea and off the west coast of Scotland), and of the apparatus used and the difficulties met with. He exhibited photographs of different samples of hauls showing that the diatoms attain their maximum in spring and are at a minimum in summer, while the copepods are few in spring but numerous in summer. He pointed out the necessity for taking samples simultaneously with vertical and horizontal nets, and for using coarse and fine nets in order to gain a true picture of the total plankton, and referred to the irregularity in distribution of plankton organisms, swarms of organisms being sometimes present in restricted areas, hence it was necessary to be careful in drawing conclusions from the samples taken in a single haul. He briefly discussed the application of plankton investigations to fishery problems, pointing out that diatoms are the ultimate food of marine animals, and therefore the starting-point of the problems.

The Abrolhos Islands.

Prof. W. J. Dakin gave a summary of some of the results of recent work by himself and Mr. W. B. Alexander on the Abrolhos Islands. These are situated in lat. 28° 40′ S., about fifty miles off the west coast of Australia, and near the edge of the continental shelf. The depth of water between the islands and the mainland averages about 25 fathoms, while a few miles west the depth is some hundreds of fathoms. The islands are composed entirely of coral, all the rock above sea-level (the highest point in any of the islands is 50 ft.) being uplifted coral rock or sand. There are distinct traces of a very recent uplift of about 8 ft., but at an earlier date—quite recent geologically—a much greater uplift put the islands in connection with the mainland. As a consequence of this former land connection certain of the islands are now inhabited by large numbers of wallabies, several species of amphibia, and many species of reptiles. There is thus a combination of the features of coral islands and the continental terrestrial fauna. There is evidence that a warm tropical current flows southwards and reaches the Abrolhos, and possibly accounts for certain tropical characters of the fauna of the islands. The neighbouring mainland is bathed by cooler waters, probably of southern origin. Prof. Dakin recorded from the islands a considerable number of interesting animals, including a new species of Ptychodera allied to *P. flava*.

The Development of Trypanosomes in the Invertebrate Host.

Prof. E. A. Minchin showed that if an analysis and comparison be made of those instances in which it can be claimed that the development of a given species of trypanosome in its invertebrate host is known, it is seen that in every such instance there is a part of the developmental cycle which is constant in occurrence and uniform in character, and another part which is of inconstant occurrence and variable in character.

In the constant part of the cycle the parasite always assumes the crithidial type of structure and multiplies incessantly in this form to produce a lasting stock of the parasite, certain individuals of which change sporadically from the crithidial into the trypaniform type and so become the final, propagative form of the development, destined to pass back into the vertebrate host and establish the infection in it. During hunger-periods the crithidial forms may pass temporarily, in some cases (*e.g.* the trypanosome of the skate in the leech Pontobdella), into the resting, non-flagellated leishmanial form, until food is again abundant, when they form a new flagellum and revert to the crithidial type of structure.

The inconstant part of the cycle, when it occurs, is intercalated at the very beginning of the development in the invertebrate, and lasts but a relatively short time; it is derived directly from the trypanosomes taken up by the invertebrate from the vertebrate host, and takes the form of an active multiplication of the parasites in either the trypaniform (*e.g.* *Trypanosoma gambiense* in the tsetse-fly) or leishmanial (*e.g.* *T. cruzi* in the bug Conorhinus) condition. In the cases where this early multiplicative phase is wanting altogether, the trypanosomes taken up by the invertebrate host pass at once into the crithidial phase (*e.g.* *T. vivax* in tsetse-fly).

When a further comparison is made between the development of trypanosomes in the invertebrate host and the development of the closely allied species of

Crithidia (*e.g. C. melophagia* in the sheep-ked) and Leptomonas, which have no alternation of hosts or generations, but are confined during their entire life-history to particular species of invertebrate hosts, it is seen at once that the life-cycles of these parasites of invertebrates are similar in all essential points to the crithidial phases of trypanosomes in their invertebrate hosts. It is evident, therefore, that the crithidial phase in the development of a trypanosome is to be interpreted as a reversion to, or recapitulation of, the type of development that occurred in the ancestral form which was originally a parasite of the invertebrate alone, before it had obtained a footing in the vertebrate host or had acquired the trypanosome-like type of structure; while the multiplicative phases of variable character preceding the crithidial phase in trypanosome-development are to be regarded as having been intercalated secondarily into the life-cycle and of no phylogenetic significance.

Australian Haematozoa.

Dr. J. Burton Cleland remarked that, owing to the geographical isolation of Australia, the study of the blood-parasites of the vertebrates, especially of such as have no easy means of passing over stretches of ocean, is of considerable interest. In some cases, *e.g.* the marsupials, speculation arises as to whether the hæmogregarines found in them reached Australia (1) with the marsupials when these originally came; (2) as parasites of the invertebrate host by a separate arrival; or (3) whether their appearance represented the adaptation in Australia of a parasite, at one time confined to an invertebrate host, to a habitat partly in a vertebrate and partly in an invertebrate host. Dr. Cleland considered the first of these suggestions to be the most reasonable. He directed attention to the records of the principal protozoon parasites of the blood of Australian vertebrates. Plasmodium seems to be rare in birds, while Halteridium is common. Trypanosomes have been found in several species of birds, and often in the same infected birds are large parasites, apparently the intracorpuscular form of the trypanosome.

Australian Trematodes and Cestodes.

Dr. S. J. Johnston passed in review the principal Australian Trematodes and Cestodes, and stated that the entozoan fauna of the host-animals belonging to any particular class of vertebrate might be separated into two divisions: (1) those which have been parasitic in these hosts for a very long time, practically from the first appearance of the host-animals; and (2) those which represent more recent acquirements. The members of the former division may be readily recognised by the fact that they have near relatives parasitic in other branches of the same stock, while members of the latter division generally have not. The members of each genus (or sometimes of several closely related genera) in the former division, in many cases scattered all over the world, constitute a natural group, and must be regarded as derived from common ancestors. These ancestors were parasites of the progenitors of the host-animals in the very early days when the group was much more restricted in its distribution than it is at the present time. A study of the relationships and distribution of the parasites affords some circumstantial evidence of the past movements and paths of dispersal of the host-animals. Dr. Johnston instanced the entozoan fauna of marsupials in Australia, which comprises a number of Cestodes (*e.g.* Linstowia) and Trematodes (*e.g.* Harmostomum), the nearest relatives of which are found in species of the same genera which live parasitic in South American marsupials.

Parasitic Worms of Queensland.

Dr. Wm. Nicoll stated that the hook-worms, Ankylostoma and Necator, are the most common human parasites in Queensland, but these worms are not more common there than in temperate regions. Hydatids are much rarer in Queensland than in other parts of Australia. Dr. Nicoll gave a brief general account of the more important parasites observed in animals in Queensland, and referred in particular to *Onchocerca gibsoni*, the round-worm which causes nodular disease in cattle. The life-history of this worm still remains unknown, but a considerable amount of experimental work has been carried out thereon. It has been suggested that infection is either direct (taking place in young animals) or by the agency of some biting insect. Dr. Breinl's experiments indicate the possibility of infection by means of water, for he was able to induce larvæ of Onchocerca to pass out through the unbroken skin, and to emerge into water where, however, they lived only a short time. Attempts to infect various aquatic animals with the larvæ were unsuccessful. Larvæ ingested by the stable-fly (Stomoxys) were able to live therein for several days, but Dr. Cleland could not detect any development in these larvæ. Dr. Nicoll applied sterile water on a calico pad, or in a glass vessel, to the skin of a cow over an Onchocerca nodule, but did not obtain larvæ. Experiments on excised nodules placed in water showed that the larvæ can, and do, make their escape through the capsule enveloping the worm-nodule, and therefore may be found close to the surface of the body in such positions that they can be readily ingested by a biting insect.

Studies on Echinoderm Larvae.

Dr. T. Mortensen gave an account of his recent work at Misaki (Japan), undertaken with the object of studying the inter-relationships between larval and adult forms of Echinoderms, and of testing the view that within the different families the larvæ have certain structural features in common, for if this prove to be a general rule larval characters may be of considerable importance in helping to settle doubtful cases in Echinoderm classification. Dr. Mortensen reared more or less completely sixteen species. Among these were three Temnopleurids, the larvæ of which have been hitherto unknown. This family has a special form of larva characterised by peculiarities of its skeleton. Four species of Clypeastroids—*Clypeaster japonicus*, Mellita sp., *Laganum fudsiyama*, and *L. decagonale*—were reared; their larvæ all proved to be of the type characteristic of other Clypeastroids. *L. fudsiyama* is a deep-water species (200–1000 mètres), and this is the first time that the larva of a deep-water Echinoderm has been reared. The larva is pelagic and of typical Clypeastroid structure. *L. decagonale* has large eggs, rich in yolk, and in correlation with this the development is shortened, the whole metamorphosis being completed in three to four days. The larva takes no food, the mouth being rudimentary; there is no ciliated band, but a strong general ciliation. The larval skeleton is rudimentary, but of the usual Clypeastroid form; only four larval processes at most are developed, but generally only two, sometimes one, three, or none. *Asterina pectinifera* was found to have a pelagic larva, while the two other species, the development of which is known, take care of the brood and have non-pelagic larvæ. The larva of this species has a Brachiolaria stage, thus proving the correctness of the view that the larval appendages in the young *A. gibbosa* are homologous with the brachiolarian processes of free-swimming larvæ.

Sheep-maggot Flies.

Mr. W. W. Froggatt exhibited specimens of four species of Diptera, the larvæ of which have been found on sheep in New South Wales. The common blow-fly (*Calliphora villosa*) is a serious pest to wool-growers, as it "blows" the soiled wool on the backs of living sheep, and the resulting maggots feed upon the wool-substances, and when full grown fall out and pupate on the ground. This fly will also "blow" meat or any kind of animal matter. Two other species of Calliphora (*oceaniae* and *rufifacies*) also attack sheep and all kinds of animal matter. The fourth fly—*Lucilia sericata*, the green-bottle fly—is the common sheep-maggot fly in Britain, but although found at times breeding in living wool in Australia, is not common in living wool, but is found about Sydney commonly living on all kinds of animal and vegetable matter, and congregating on plants and shrubs. Although it will "blow" meat placed outside, it seldom enters houses as do the common blow-flies. *C. rufifacies* had not been recognised as a sheep-fly as late as 1910, and had not up to that date been bred from the maggots found in soiled wool, though in the west of New South Wales the fly was plentiful about killing yards, freshly skinned sheep, and dead animals. This fly seems to have recently adopted the habit of "blowing" the wool owing to the presence of soiled and "smelly" wool, and in the north and west of the state this is now the common sheep-maggot fly, while the two other species do comparatively little damage in those areas. Mr. Froggatt also exhibited a Chalcid (*Nasonia brevicornis*) which was found to infest the larvæ and pupæ of *C. rufifacies*, and remarked that the discovery of this parasite was important and might possibly lead to new methods of control of the sheep-maggot flies.

The Emergence of the Nymph of ANAX PAPUENSIS.

Mr. R. J. Tillyard described the emergence of the nymph of this insect (order Odonata). During the three days previous to hatching, the beats of the dorsal vessel increase in number from about 30 to nearly 100 per minute, and just before hatching a cephalic heart appears in the posterior head region which drives blood forward into the head. The pressure thus caused forces off the cap of the egg and the nymph emerges quickly, swathed in an outer sheath (the "amniotic covering," Balfour Browne), which is found to be a non-cellular chitinous cuticle, not related in any way to the amnion, but representing the first moult of the larva. The swathed stage, which may be termed the pro-nymph, lasts only a few seconds. The cephalic heart increases enormously and consists of two large chambers which pulsate regularly and drive blood into the head. The latter quickly swells to twice its original size, and thus the pro-nymphal sheath is split dorsally and the young nymph emerges, freeing itself from the sheath by a few convulsive struggles. The cephalic heart quickly subsides in the free nymph. Meanwhile a rectal pulsating organ pumps water into the rectum, the branchial basket there being thus distended, and the whole tracheal system of the nymph becomes gradually filled with air. It is suggested that the rupture and atrophy of the amnion, described by Brandt in the embryology of Odonata, is due to the formation of the pro-nymphal sheath, which forms a close-fitting and far more efficient protection to the embryo.

Scent-distributing Apparatus in Lepidoptera.

Dr. F. A. Dixey pointed out that certain specialised scales found in various situations on the wings, bodies, and limbs of Lepidoptera are well known to be concerned in the distribution of a scent, which is in many cases characteristic of the species. These scales may occur in both sexes, but certain forms of them, *e.g.* the plume-scales of Pierines and Nymphalines, have been found only in males. The Pierine plume-scale often affords a ready means of identifying the species, and is frequently of service in throwing light on questions of affinity.

In some cases a special adaptation exists with the object of economising the scent until it is required for purposes of sexual recognition or attraction; for instance, the costal folds of the fore wing in many Hesperids, and the collection (seen in many Pierines and in some Satyrines and Nymphalines) of the scent-distributing scales into a patch, situated on that portion of the fore or hind wing which is covered in the position of rest.

Mimicry.

Prof. Poulton, after remarking that Australia is the most isolated of all the inhabited continental tracts, considered how far this is reflected in the insect-models and their mimics, and stated that although the subject had hitherto been little studied in Australian material, there were already conclusions of much interest.

Perhaps the most widely spread models in the world are the black, yellow-banded, stinging Hymenoptera. The central members of these powerful combinations are wasps (Diploptera), around which are ranged sand-wasps (Fossores), and, in far smaller numbers, bees (Anthophila), followed by mimetic species of the phytophagous Hymenoptera, and of other orders—Diptera, Coleoptera, Lepidoptera, etc. Throughout this dominant combination of models and mimics the sub-cylindrical body is black, encircled by many bright yellow bands; although widespread over the world, it is especially powerful in the north temperate zone. In Australia, however, its place is taken by a combination with a distinct pattern; the bands are deep-brownish orange (instead of yellow), and are few and broad (instead of many and narrow). This pattern runs through a large and complex set of models and mimics. Prof. Poulton remarked that it was very convincing to compare such a mimetic Asilid fly as the European *Asilus crabroniformis* with the Australian species, and to observe how their very different patterns resemble those of the respective Aculeate models, and that an equally significant comparison may be drawn between the mimetic Longicorn beetles of these two parts of the world.

A question as to whether insects in different geographical areas resembled each other in colour and pattern was answered by Dr. Dixey, who stated that such cases did occur, but were very exceptional, and should, in his opinion, be regarded as mere coincidences. There were no such coincidences known where complex patterns were involved, but when a simple pattern is concerned it may occur more commonly in widely different parts of the world.

Experiments on Silkworms.

Prof. Otto Maas gave an account of his experiments on the feeding of silkworms on different foods, *e.g.* mulberry and Scorzonera. When both parents were fed on Scorzonera the capacity of fertilisation is much inferior to normal, the number of eggs deposited is much fewer, and of the eggs fertilised fewer hatch. In the case where only one parent is fed on Scorzonera the mating may be as fertile as a normal one. A cross between a Scorzonera-fed and a mulberry-fed strain seemed to be superior in strength to one fed only on mulberry.

Species of Victorian Lampreys.

Dr. J. A. Leach stated that examination of 46 lampreys in the National Museum and the University Museum, Melbourne, showed a remarkable amount of variation in almost every character used by systematists to distinguish different species. In six specimens of *Geotria chilensis* taken alive at the same time, the length of the interspace between the two dorsal fins varied from 0·6 of the length of the dorsal fin to 1·3 times that length. Dr. Leach divides the 24 specimens of Geotria examined into three species, and the 22 specimens of Mordacia into two species. The remarkable, large pouch of *Geotria australis* is not a secondary sexual character, for it is present in females as well as in males; its use is not known.

Notes on Australian Frogs.

Mr. J. Booth commenced work on the Australian frogs in the hope of finding some method of identification without resort to the dissection necessary to examine the sternal apparatus and the sacral vertebræ, but found that description and measurement of the external features could not replace observations on the skeletal girdles, the characters of which are of paramount significance, while the external configuration is more related to the mode of life of the animals and largely corresponds with the classification into swimming, climbing, burrowing frogs. The frogs found in Australia belong almost entirely to the three families of the Arcifera—Cystignathidæ, Hylidæ, and Bufonidæ. To these must be added the family Ranidæ (of the Firmisternia) on account of the occurrence of *Rana papua* in New Guinea, and on account of the recent record of three species of the genus Austrochaperina. Mr. Booth remarked on certain varieties of interest and on the occurrence of abnormal examples, the significance of which was suggested.

Migration of Birds.

Prof. C. J. Patten referred to some features in the diurnal migration of pipits, wagtails, and swallows as observed at Tuskar Rock Light-station (Co. Wexford). In certain periods of spring and autumn a procession of migrants passes this station daily, but owing to the barren nature of the rock comparatively few birds alight. Most birds fly towards the land, even those presumably on emigration. Pipits and wagtails were estimated to travel at about 20 miles per hour, swallows and martins at about 90 miles per hour. On account of the very limited area of the rock, and the considerable altitude at which many of the birds fly, the descending flight for the purpose of alighting, when attempted, is almost perpendicular.

Photographs of Narwhal and Beluga.

Prof. H. F. E. Jungersen exhibited photographs taken at Umanak in Western Greenland by a Danish physician. The first series was of full-grown male narwhals, and showed clearly that the tusk pierces the skin of the left side of the snout above and outside the mouth-opening. Prof. Jungersen remarked that neither text-books nor original descriptions by authors who have examined the narwhal in the flesh give clear statements of the exact relation of the tusk. There is, however, one exception: J. Anderson (1746) states definitely that in a narwhal captured in the Elbe the tusk pierces the left upper lip. The photographs of the Beluga prove that the front end of the snout, under the rounded forehead, forms a short but distinct beak. Most descriptions deny the existence of a "beak," or do not mention it, but in some of the better figures (*e.g.* by Scoresby and Flower) a "beak" is clearly shown.

The Sizes of the Red Blood Cells of Some Vertebrates.

Dr. J. Burton Cleland summarised a series of systematic measurements of the red blood corpuscles of various Australian vertebrates, and stated that the figures seem to indicate that with specialisation has come eventually, both in fishes and birds, a diminution in size of the red cells. The relationships of the various classes of animals to each other is clearly shown in the size of the red cells; those of Elasmobranchs approximate more nearly in size to those of Batrachians and Reptiles than do the red cells of Teleostean fishes. The enormous red cells of the Dipnoi, those of Ceratodus being $39 \times 25\,\mu$, approach those of the Urodela (the red cells of Proteus are said to be $58 \times 35\,\mu$, and those of Amphiuma $77 \times 46\,\mu$). In the frogs and reptiles the size of the red cells has decreased, and in birds the "oldest" forms show distinctly a tendency to larger cells than the more specialised ones, the smallest red cells (10 to 12×5 to $7\,\mu$) being met with in some families of Passerine birds, while the largest ($16 \times 9\,\mu$) are found in the emu.

The Heredity of Some Emotional Traits.

Prof. C. B. Davenport observed that while sociologists, who place great stress on the importance of conditions in determining human traits, have been forced to admit the hereditary basis of feeblemindedness, they still hold, for the most part, to the view that in the moral field heredity plays little part. To test this view, inquiry was undertaken into the inheritance of traits of persons of the criminalistic type, the base of the study being the family history of 165 wayward girls in State institutions of the United States. About 20 traits were considered in some detail; many did not yield any clear-cut results, but in a least five the hereditary factor was clear, and evidently determined the behaviour. (1) The tendency to tantrums or violent outbursts of temper is inherited in adults as a dominent trait, *i.e.*, does not skip generations. In several instances it was possible to trace back the tendency three, four, and even five generations. (2) Violent eroticism was similarly traced back; half of the offspring of a highly erotic parent show similar impulses. (3) Impulsions to suicide are accompanied by depressions, and it appears that this depression is inherited as a recessive or negative character. It ordinarily skips generations, but the tendency is generally found on both sides of the parentage of the affected individual. (4, 5) Two other traits—dipsomania and nomadism—appear to be sex-linked characters transmitted through mothers to some or all of their sons. They appear in daughters typically only when shown by the father and when the tendency is also carried by the mother. If both parents show the trait, all the children have the tendency to develop the trait in due time.

The Hormone Theory of Heredity.

Dr. J. T. Cunningham held that Mendelism throws no direct light on the origin of characters; it deals merely with their transmission. It is inferred, however, by Mendelians that characters transmitted as units arose as units. From the evidence of Mendelian researches it is reasonable to conclude that non-adaptive specific and other diagnostic characters arose in the course of gametogenesis and conjugation, but the doctrine of Mendelism or mutation was, in Dr. Cunningham's opinion, not applicable to the phenomena of adaptation. He cited in support (1) Animals such as the frog, flat-fish, and caterpillar, which exhibit adaptation to two quite different sets of conditions in the individual life, and he held that it was impossible to believe that such transformation was due to mutations not caused by the external conditions, for there is no evidence that the necessary gradual changes could occur unless the conditions produced them. (2) The phenomena of secondary sexual characters, of which one of the most impressive and fully investigated is that of the antlers of the stag. The Mendelians regard such characters merely as mutations which are coupled with primary sex; but primary sex is determined at fertilisation, and such secondary characters have been shown to be dependent on the presence and function of the gonads. Characters which are determined in the gametes are not generally affected by amputations of the gonads or any part of the body in after life. It has been shown that the effects of castration on the development of secondary sexual characters are due to the stimulus of chemical substances produced by the gonads, especially in their functional activity.

The hormone theory explains how somatic modifications may be transmitted to the gametes, the hypertrophied tissue giving off chemical substances or hormones which stimulate the determinants in the gametes. A special application of this principle is necessary in the case of the functional secondary sexual characters to explain how it is that their development is so closely dependent on the functional activity of the gonads. This special part of the theory assumes that the original modification was produced in the presence of the hormone from the sexual organs, and consequently the inherited modification cannot develop in the soma except in the presence of this hormone.

The following communications were also made to the section, but in the absence of the specimens and diagrams used in illustration they do not lend themselves to the purposes of a summary.—Prof. Poulton gave an account of Dr. Perkins's researches on the colour-groups of Hawaiian wasps, Prof. Jungersen described the anatomy of Pegasus, which he showed to be an Acanthopterygian, and to require at least a suborder of its own, for it is distinguished by several structural peculiarities from all known fishes; Mr. T. Steel exhibited beautifully preserved examples of several species of Peripatus and of Australian land planarians, and added observations on their special features and habits; and Mr. E. de Hamel gave a general account of the ringing of birds and some of the observed results.

J. H. ASHWORTH.

THE SUPPLY OF CHEMICALS TO BRITAIN AND HER DEPENDENCIES.[1]

AFTER showing that the foundations of theoretical chemistry were laid almost exclusively by the chemists of England, France, and Sweden, the speaker proceeded to discuss the position of industrial chemistry. The "Report on Chemical and Pharmaceutical Products and Processes" in the International Exhibition of 1862, from the pen of A. W. Hofmann, then professor of chemistry in the Royal College of Chemistry and Royal School of Mines, London, contains the following passage (p. 3):—"The contributions of the United Kingdom, and in particular the splendid chemical display in the Eastern Annexe, prove the British not only to have maintained their pre-eminence among the chemical manufacturers of the world, but to have outdone their own admitted superiority on the corresponding occasion of 1851."

Statistics in relation to the development of the alkali trade show how rapidly the production of what are called "heavy chemicals" was proceeding at this period. Figures derived from returns collected by Mr. Christian Allhusen from 81 per cent. of the manufacturers in the United Kingdom, immediately after the first Great Exhibition, are shown below. These may be compared with statistics prepared by Mr. W. Gossage for the year 1861 immediately before the exhibition of 1862[2]:—

	1852 Tons	1851 Tons
Soda ash	71,193 ...	156,000
Soda crystals	61,044 ...	104,000
Bicarbonate	5,762 ...	13,000
Bleaching powder ...	13,100 ...	20,000

The value of these products for 1852 was estimated at about 1¼ million pounds, while the value of the products of 1861 was calculated by Mr. Gossage at upwards of two millions sterling.

The Board of Trade has recently issued a bulletin concerning German competition in the United Kingdom market, and on p. 2 we find the statement that the soda compounds, excluding chromates and bleaching powder, produced in the United Kingdom in the year 1907, are valued at 3,390,000*l*. The imports from Germany in 1912 are valued at only 8700*l*. As to bleaching materials, the product of the United Kingdom for 1907 is estimated at 527,000*l*., while the import from Germany for 1912 was 44,600*l*.

From these figures the easy deduction is made that "the imports of these chemicals into the United Kingdom from Germany are relatively insignificant when compared with the output of the same articles in this country. It is clear that in these particular lines British manufacturers have no need to fear German competition in the home market."

Similar remarks apply to aluminous compounds, coal-tar products not dyes, the cyanides, sulphuric acid, and other acids for which the bulletin may be consulted. It thus appears that the British manufacturers of sulphuric acid and soda, from the early times of a century ago, have been able, up to the present, to hold their own against foreign competition, and have thus added substantially to the revenues and well-being of their country.

Now leaving to the department of "heavy chemicals" all such things as agricultural and horticultural washes, coarse disinfectants, and artificial manures, the question arises, How do we in England stand in regard to the supply of drugs, dyes, photographic chemicals, agents for research, and perfumes at a time when many of these things are very urgently needed?

It may be safely asserted that the sources of supply of all these materials in the United Kingdom are seriously inadequate. And, further, we may point to the acknowledged fact that many of the dyes, nearly all the synthetic drugs, and photographic materials have been systematically imported from Germany.

The annual statement of the Board of Trade (p. 108) shows that in 1913 we imported from Germany:—

	£
Alizarin and anthracene dyes ...	271,119
Aniline and naphthalene dyes ...	1,382,478
Synthetic indigo	76,681
	£1,730,278

Under the head of "Drugs, unenumerated, including Medicinal Preparations" (p. 107), out of a total of imports from foreign countries and from British possessions amounting to 1,302,860*l*., more than one-fourth, or to the value of 332,464*l*., was in 1913 received from Germany. From this is to be deducted the inconsiderable amount of dyes and other chemicals from coal-tar, valued at 24,691*l*., exported in 1913 to Germany (p. 300). According to the Final Report on the First Census of Production of the United Kingdom for 1907 (p. 547), this country made 139,000 cwt. of coal-tar dyes, valued at 373,000*l*., of which practically the whole was consumed at home.

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[1] Abstract of a paper read before the Royal Society of Arts on November 25 by Sir William A. Tilden, F.R.S.

[2] Gossage's "History of the Soda Manufacture."

As to fine chemicals for analysis and for research, there are no figures available, but it may safely be said that there has been no appreciable production of these things in this country.

If we are ever to be in a position to supply ourselves and our Dependencies with the dyes, the drugs, and the rest of the fine chemicals required in our work, it will only be achieved after a careful review of the circumstances which led to the removal of the industries from this the country in which many of them originated, together with a determination to take to heart the lessons of the past.

After a review of these circumstances in which it is shown that it has not been due to inactivity on the part of scientific chemists, but to the ignorance and neglect of British manufacturers down to quite recent times, the author considered what ought to be done and what it is possible to do in this country to remove reproach from British chemical industry, and to render the Empire independent of supplies from foreign sources.

We need many first-rate chemists, a few engineers, plenty of capital, and some good men of business. A combination of these elements in due proportion is certain of success, and the time, though so unhappy for the world, is favourable for this enterprise.

Inasmuch as the functions of each and the best way of combining them have already been settled in practice on the Continent, is to be hoped that the ancient precept about being taught by the enemy—*fas est et ab hoste doceri*—will not be forgotten. For there can be no doubt that the principle acted on in all German chemical factories, namely, the employment of the best available scientific skill and the constant appeal to scientific research, has been the secret of their success.

In conclusion, two remarks only require to be made. The establishment of what will be practically a new industry in this country will require consideration and assistance from the State, if it is to survive the period of fierce competition which will follow the conclusion of the war. Encouragement is already promised to the dye industry, in the form of definite financial aid to be given by Government. But remembering that the colour-maker is dependent on the production of many chemicals, which represent intermediate stages in the processes which lead from the raw materials to the finished product, and that the production of these chemicals is naturally associated with other chemical manufactures, it is to be hoped that the temporary protection will be extended beyond the immediate field of the colour-maker.

The other remark may raise a smile on the part of those business men who are moved only by commercial considerations. There will be a great temptation when the war is over to resume former business relations with the enemy. The German chemical manufacturers have a powerful organisation and many years of experience behind them. Let them keep any markets they can retain outside the British Empire, but every man who cares for his country will surely demand that business at home shall be limited to British goods.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

EDINBURGH.—The chair of medicine and clinical medicine in the University has become vacant through the retirement of Prof. John Wyllie. With the exception of the years 1866 to 1868, when he was house physician to the General Hospital in Birmingham, Prof. Wyllie has lived his professional life in Edinburgh, where he filled many important positions as a physician, and attained a high reputation in medical circles. In addition to contributions to medical journals, he is known as the author of a book on "The Disorders of Speech," published in 1894.

As in all other universities the war has seriously depleted the classes in Edinburgh. The diminution is observable in all the faculties, but is particularly noticeable in the later years of the medical curriculum, in the third year of engineering science, and in the law classes. A considerable number of the junior staff of lecturers are also with the colours. To encourage students to offer themselves for service the University authorities have granted important privileges, so that when the war is over the studies may be resumed without serious loss of time. The great majority of the men who are attending classes are being drilled several times a week, and are receiving military instruction. The Indian students are being trained as an ambulance corps.

LONDON.—A course of nine advanced lectures on certain aspects of British ecology will be given at University College, with the exception of lecture 5, which will be given at the Botany Building, Imperial College of Science, Prince Consort Road, South Kensington, S.W., at 5 p.m. on the following dates:—December 10, Dr. E. J. Salisbury, "Woodlands"; December 17, Dr. W. G. Smith, "Grasslands"; January 14, Dr. C. E. Moss, "Unsolved Problems relating to Calcareous Vegetation"; January 21, Miss M. C. Rayner, "Some Aspects of Heath Vegetation"; January 28, Prof. J. B. Farmer, "Alpines"; February 4, Dr. E. J. Salisbury, "Determining Factors in Aquatic Distribution"; February 12, Prof. R. H. Yapp, "Fen Vegetation"; February 18, Prof. G. S. West, "The Occurrence and Distribution of Fresh-water Algæ"; February 25, Mr. A. D. Cotton, "The Algal Vegetation of the Salt-marsh and Seashore." The lectures are addressed to students of the University and to others interested in the subject. Admission is free, without ticket.

SHEFFIELD.—Dr. W. MacAdam has been appointed to the post of demonstrator in public health, and Mr. T. Chetwood to the post of lecturer on hygiene in the training department.

MR. G. S. YUILL, of Yuills, Ltd., a graduate of Aberdeen University, has made a gift of 4000*l.* to the University, the interest upon this amount to be applied in furthering the study of chemistry.

IT is announced in *Science* that the United States General Education Board has granted 50,000*l.* to Goucher College, Baltimore, conditionally upon 150,000*l.* being raised by April 1, 1917. From the same source we learn that a fund of 12,000*l.* has been turned over to Amherst College by the alumni council. The disposal of the income from this sum is to be determined by the trustees and the council.

WE learn from *Science* that on November 19 the honorary degree of doctor of science was conferred by Brown University upon Prof. W. H. Bragg, of the University of Leeds, before the corporation and faculty of the University in special Convocation. Following the conferring of the degree Prof. Bragg delivered the last of four lectures on X-rays and crystals, which he has been giving as the first of the anniversary lectures to celebrate the one hundred and fiftieth anniversary of Brown University.

NOTICE is given by the Institution of Naval Architects that a scholarship, to be known as the "Institution of Naval Architects Scholarship in Naval Architecture," will be offered for competition among students of the institution in 1915. The scholarship, which is of the annual value of 100*l.*, and tenable for three years, will be awarded in connection with the competitive examinations for scholarships, studentships, etc., to be held by the Board of Education in May, 1915, in naval architecture, pure mathematics, applied mechanics (materials and structures), and either applied mechanics (machines and hydraulics), or heat engines. Applications must reach the secretary of the Institution of Naval Architects on or before January 15.

AT the last meeting of the governors of the South-Eastern Agricultural College, Wye, the principal, Mr. M. J. R. Dunstan, reported that 110 students and thirteen members of the teaching staff, besides college servants, farm and garden employees, had joined the colours. The new college buildings have been completed at a cost of 12,500*l*., towards which the Board of Agriculture has given 6000*l*., whilst two grants, each of 500*l*., have been made by a generous anonymous benefactor towards the completion of the research equipment, and these gifts have been met by equivalent grants from the Board of Agriculture. The probable financial position of the college, owing to the reduction in the number of students, was considered, and it was decided to bring the matter before the Government educational and agricultural departments before taking any definite steps to curtail the teaching or research work. A vacuum drying plant for experimenting on the drying of fruit and vegetables has been installed by means of a grant from the Board of Agriculture, and it is hoped that assistance may be forthcoming to continue the investigations into the economical feeding of dairy cows of which a third report has just been issued. Results which may prove to be of considerable practical value have been obtained from the hop-breeding experimental work.

THE report of the Commissioner of Education of the United States Bureau of Education for the year ended on June 30, 1913, has been received from Washington. It consists of two bulky volumes running to 931 and 700 pages respectively, and every department of American education is dealt with exhaustively. For the academic year with which the report deals, the bureau received reports from 596 universities, colleges, and technological schools in the United States. Ninety-four of these institutions are controlled by States or municipalities, and 502 are administered by private corporations. The number of collegiate and resident graduate students in these institutions of higher education was during the year 128,644 men and 73,587 women, as compared with 125,750 and 72,703 in the preceding year. These numbers show on analysis an increased attendance of 2·35 per cent. of college students in graduate and undergraduate courses, and a decrease of 11 per cent. in the number of preparatory students. The Commissioner points out in his introduction that in most instances high-school work can be done better and at less cost in the regular high schools than in the preparatory classes of colleges. The decrease in the number of students in the preparatory classes of colleges is due to some extent also to the more liberal practice of the colleges in accepting for admission work in subjects other than those heretofore required.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 3.—Sir William Crookes, president, in the chair.—M. de **Lange**: The thermophone—a new form of telephone.—Dr. G. S. **Walpole**: Hermann's phenomenon. At the boundary between two solutions of unequal specific conductivity a change of reaction is developed if a difference of potential be maintained between them. Alkali is liberated if the current passes from the better conducting solution to that not conducting so well; acid, if the current passes in the opposite direction. The amounts may be calculated from the potential gradients in the solutions on each side of the boundary, the time for which the difference of potential is maintained, the resistance constant of the vessel employed, the dissociation constant of water, and the known migration velocities of hydrogen and hydroxyl ions.

Zoological Society, November 24.—Prof. E. A. Minchin, vice-president, in the chair.—D. M. S. **Watson**: (1) Description of a new reptile from the Permian of the Cape Province, South Africa. Mr. Watson regards this as derived from a Cotylosaurian ancestor and as perhaps related to Aræoscelis and the modern lizards. A new genus is founded for the reception of the so-called *Proterosaurus huxleyi*. (2) The origin of the Chelonia. A number of reasons is given for supposing that they may be descended from some such form as *Eunotosaurus africanus*, Seeley. (3) The skulls of Bauria, Microgomphodon, and Sesamodon. The relation of the group with the Cynognathids is discussed, and a new skull of Lycosuchus, in which both the prevomers and vomer are present, is described.—F. A. **Potts**: Polychæta from the N.E. Pacific: the Chætopteridæ. With an account of the phenomenon of asexual reproduction in Phyllochætopterus and the description of two new species of Chætopteridæ from the Atlantic. The new species of Phyllochætopterus was found in branched tubes, each usually containing several individuals. The origin of these colonies each from a single individual is suggested by the frequent occurrence of worms in various stages of regeneration. An examination of these shows that autotomy first occurs in the middle region of the animal's body, and a complete animal is regenerated from each of the two parts. This phenomenon appears to be characteristic also of another new species of this genus from Plymouth, which lives in small colonies in branched tubes. Several points in the morphology of the Chætopteridæ are also discussed.—E. **Heron-Allen** and A. **Earland**: Evidence of purpose and intelligence on the part of Foraminifera.

EDINBURGH.

Royal Society, November 16.—Prof. F. O. Bower, vice-president, in the chair.—Dr. D. **Ellis**: Fossil micro-organisms from the Jurassic and Cretaceous rocks of Great Britain. The paper contained a study of fossil moulds from four localities—the Frodingham Ironstone of Lincolnshire, the Secondary rocks in the Island of Raasay (N.W. Scotland), the Dunliath ferruginous Limestone, and the Gault, near Folkestone. These supplied in order a fossil mould belonging to the Phycomycetæ, with abundant examples of hyphæ, sporangia, and spores; a fossil mould provisionally named Palæomyces α; a fossil Actinomyces; and three members of Bacteria, two Bacilli, and one Micrococcus. Evidence was given that these were genuine micro-organisms, and reasons were discussed why the organism in its lifetime had a chemiotactic affinity for iron.—J. M'Lean **Thompson**: The anatomy and affinity of *Deparia moorei*. The paper dealt with the anatomical features of the axis, leaf, and sorus. Comparison with *Deparia prolifera* showed an advanced type of leaf trace, the expansive lamina being possessed of a few pinnæ and a reticulate venation—suggesting an adaptation for life in moist shade. The sori were of normally marginal origin, but occasionally truly superficial sori appeared on the upper leaf surface in *D. moorei*. This in no way invalided the conclusion that it belonged to the series Marginales. The consensus of characters justified the rejection of an alliance with Athyrium or Aspidium, but rather assigned the plant to a place in the Davallioid series of forms.—Dr. T. **Muir**: Properties of the determinant of an orthogonal substitution.

PARIS.

Academy of Sciences, November 23.—M. Ed. Perrier in the chair.—A. **Chauveau**: Physiological weakness and tuberculosis in armies in the field. The debility caused by exposure to the hardships of a campaign in no way favours the introduction of the tubercle bacillus into the body. But, once the body is attacked by the organism, the reduced power of resistance to the ravages of the bacillus caused by privation and insanitary conditions may have a marked effect on the rapidity of development of the disease.—E. L. **Bouvier**: The carcinological fauna of Maurice Island. A description of some specimens collected by M. Carié during the last four years.—Haton de la **Goupillière**: A property of arithmetical progressions.—M. **Gonnessiat**: Observation of the transit of Mercury across the sun, November 6–7, at the Algiers Observatory. The transit was observed under excellent atmospheric conditions. The times of the four contacts are given and compared with the calculated data.—Henri **Chrétien**: The transit of Mercury across the sun of November 7, 1914. Details of observations made at Nice.—Comas **Solá**: Photographic observations of a small planet, apparently new. The photographs were obtained on November 15 at the Fabra Observatory, Barcelona.—C. Le **Morvan**: Photographic positions of comet 1913*f* (Delavan) obtained with the photographic equatorial at the Paris Observatory. Positions are given for September 5 and 6, October 7, 8, and 9.—Charles **Rabut**: The La Balme bridge.—André **Kling** and H. **Copaux**: The preserved meat of the Paris camp. A reply to a recent criticism of M. Balland.—Marcel **Rostaing**: A type of military under-garment.

NEW SOUTH WALES.

Linnean Society, September 30.—Mr. W. S. Dun, president, in the chair.—Dr. C. **Hall**: The evolution of the Eucalypts in relation to the cotyledons and seedlings. In regard to the form of the embryo in the Eucalypts, the cotyledons in the *E. corymbosa* group closely resemble those of Angophora, and are entire and reniform. With reference to the cotyledon-leaves of Eucalyptus, these may be divided into two great classes, entire and emarginate; and each of these into groups, according to size and shape. A study of the cotyledons supports the view that the *E. corymbosa* group is the most primitive type, while the Stringybarks have cotyledons of similar form. In response to the xerophytic conditions of Australia, the Eucalpyts have reduced the size of their cotyledons—first, by a general reduction in size, while retaining the entire, reniform shape; secondly, by the introduction of emargination, which, at last, becomes so extreme that Y-shaped cotyledons come to prevail in many of the dry-country species. The first pairs of leaves tend rapidly to assume the typical form of the juvenile foliage of the species, except in the Corymbosas, where, for a few pairs, the peltate form is adopted. Seedlings of about 150 species are figured.—Dr. R. **Greig-Smith**: Note on the bacteriotoxic action of water. When *B. prodigiosus* is used as a test-bacterium, and seeded into filtered tap-water, it generally increases. In boiled water, the rate of multiplication is lessened. Under the same conditions, *B. typhi* always decreases, and, in boiled water, the diminution is increased to such an extent that from three to six cells, out of 1000 added, remain after twenty hours.—Dr. R. **Greig-Smith**: Note on the destruction of paraffin by *B. prodigiosus* and soil-organisms. When *B. prodigiosus* is grown in the presence of paraffin, it attacks the hydrocarbon. Losses varying from 5 per cent. to 14 per cent. were obtained. Mixed soil-organisms, under the same conditions, destroyed from 11 per cent. to 49 per cent.

CAPE TOWN.

Royal Society of South Africa, October 21.—Dr. L. Péringuey, president, in the chair.—J. B. **Pole-Evans**: Some new South African aloes. The paper describes six new aloes from the Transvaal.—Th. **Wassenaar**: Optical illusions.—E. J. **Goddard** and C. S. **Grobbelaar**: A new genus of fresh-water Oligochætes (of uncertain position).—J. S. v. d. **Lingen**: The space-lattice of liquid crystals. The theory of the identity of molecules which cause the different forms of crystals of the same substance was discussed briefly. Experiments on the magnetic nature of certain liquid crystals were then described. The principal axis of the molecules lies parallel to the lines of magnetic force when the molecules are not influenced by other forces. As regards the optical properties of liquid crystals, the pseudo-isotropic layers behave like uniaxial crystals cut perpendicular to the axis. Vorlaender's experiments on such layers in convergent light show the well-known rings and crosses of uniaxial crystals. He believes that the pseudo-isotropic layers have space-lattices. When Röntgen rays are passed through such layers no interference phenomenon is obtained, hence there is no space-lattice. This indicates that: (1) the molecule itself is a small crystal possessing magnetic axes; (2) a change in the structure of the molecule itself causes a change in the form of the crystals of the same substance.

BOOKS RECEIVED.

Transactions and Proceedings of the Botanical Society of Edinburgh. Vol. xxvi. Pt. 3. Session 1913–14. Pp. xxxiii + 299. (Edinburgh: Botanical Society.)

Canada. Department of Mines. Mines Branch. Magnetite Occurrences near Calabogie, Renfrew County, Ontario. By E. Lindeman. Pp. 16. Moose Mountain Iron-Bearing District, Ontario. By E. Lindeman. Pp. 14 + 8 maps. (Ottawa: Government Printing Bureau.)

Fighting in Flanders. By E. A. Powell. Pp. xix + 227. (London: W. Heinemann.) 3*s*. 6*d*. net.

Boilers, Economisers, and Superheaters: their Heating Power and Efficiency. By Prof. R. H. Smith. Pp. viii + 128. (London: Crosby Lockwood and Son.) 7*s*. 6*d*. net.

The City of Dancing Dervishes and other Sketches of Studies from the Near East. By H. C. Lukach. Pp. xi + 257. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

Through the Grand Canyon from Wyoming to Mexico. By E. L. Kolb. Pp. xix + 344. (London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

Text-Book of Embryology. Edited by W. Heape. Vol. i., Invertebrata. By Prof. E. W. MacBride. Pp. xxxii + 692. (London: Macmillan and Co., Ltd.) 25*s*. net.

The Excavations at Babylon. By R. Koldewey. Translated by A. S. Johns. Pp. xix + 335. (London: Macmillan and Co., Ltd.) 21*s*. net.

Macmillan's Geographical Exercise Books. II.—Europe. With Questions. By B. C. Wallis. Pp. 48. (London: Macmillan and Co., Ltd.) 6*d*.

Bricks and Artificial Stones of Non-Plastic Materials: their Manufacture and Uses. By A. B. Searle. Pp. vi + 149. (London: J. and A. Churchill.) 8*s*. 6*d*. net.

William James and Henri Bergson, by Dr. H. M. Kallen. Pp. xi+248. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press.) 6*s.* net.

Water Reptiles of the Past and Present. By Prof. S. W. Williston. Pp. vii+251. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press.) 12*s.* net.

Institute of Chemistry of Great Britain and Ireland. Proceedings. Part iv. Pp. 32. (London: Institute of Chemistry.) 1*s.* net.

The Teaching of Mathematics in Australia. By Prof. H. S. Carslaw. Pp. 79. (Sydney: Angus and Robertson; London: Oxford University Press.) 2*s.* 6*d.* net.

An Introduction to the Geology of New South Wales. By C. A. Süssmilch. Second edition. Pp. xviii+269. (Sydney: Angus and Robertson; London: Oxford University Press.) 7*s.* 6*d.* net.

The Butterflies of Australia: a Monograph of the Australian Rhopalocera. By G. A. Waterhouse and G. Lyell. Pp. vi+239+plates. (Sydney: Angus and Robertson; London: Oxford University Press.) 42*s.* net.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland. Thirty-first Annual Issue. Pp. vi+376. (London: C. Griffin and Co., Ltd.) 7*s.* 6*d.* net.

What is Adaptation? By Dr. R. E. Lloyd. Pp. xi+110. (London: Longmans and Co.) 2*s.* 6*d.* net.

Through the Brazilian Wilderness. By T. Roosevelt. Pp. xiv+374. (London: John Murray.) 18*s.* net.

The Journal of the Natural History Society of Siam. Vol. i., No. 2. (London: Luzac and Co.) 6*s.*

DIARY OF SOCIETIES.

THURSDAY, December 10.

Royal Society, at 4.30.—The Measurement of Arterial Pressure in Man. I.: The Auditory Method. II.: A Schematic Investigation: M. Flack, Prof. L. Hill and J. McQueen.—The Electrical Conductivity of Echinoderm Eggs, and its Bearing on the Problems of Fertilisation and Artificial Parthenogenesis: J. Gray.—The Endemic Flora of Ceylon with Reference to Geographical Distribution and Evolution in General: Dr. J. C. Willis.

Mathematical Society, at 5.30.—Simultaneous Equations, Linear or Functional: E. H. Neville.—Integrals and Derivatives, with respect to a Function: W. H. Young.

Institution of Electrical Engineers, at 8.—Automatic Protective Switchgear for Alternating Current Systems: E. B. Wedmore.

FRIDAY, December 11.

Royal Astronomical Society, at 5.—The Temperature Coefficients of the Edinburgh Transit Circle: R. A. Sampson and E. H. Baker.—Observations of the Transit of Mercury, 1914, November 6–7, made at the University Observatory, Warsaw: S. Tscherny.—The Transit of Mercury, 1914, November 6–7: Rev. A. L. Cortie.—Micrometrical Measures of 110 Wide Double Stars: W. S. Franks.—The Nebula Hv. 20 Ceti: Mrs. Isaac Roberts.—*Probable Paper:* Prof. Turner's Theory of a Sun-spot Swarm of Meteors Associated with the Leonids: R. A. Sampson.

Malacological Society, at 8.—The Geographical Distribution of *Purpura lapillus* (L.): Rev. A. H. Cooke.—The Non-Marine Mollusca of a Post-Pliocene Deposit at Apethorpe, Northants: A. S. Kennard and B. B. Woodward.—Monstrosities of Cypræa: L. St. G. Byne.—Monstrosities in *Littorina rudis*: J. E. Cooper.

Junior Institution of Engineers, at 8.—Circulation of Boilers: L. Le Soeur.

MONDAY, December 14.

Royal Geographical Society, at 8.30.—Frontier Work on the Bolivia-Brazil Boundary: Capt. H. A. Edwards.

Royal Society of Arts, at 8.—The History and Practice of the Art of Printing: R. A. Peddie.

Aristotelian Society, at 8.—Symposium: Instinct and Emotion: W. McDougall, A. F. Shand, and Prof. G. F. Stout.

Society of Engineers, at 7.30.—Annual General Meeting.

Victoria Institute, at 4.30.—The Principles of World Empire: E. W. Maunder.

Junior Institution of Engineers, at 8.—Presidential Address: The War and Engineering: The Marquis of Graham.

TUESDAY, December 15.

Royal Statistical Society, at 5.—A Further Note on the Fertility of Marriage in Scotland. Errors of Statement as to the Duration of Marriage: Dr. J. C. Dunlop.—Notes on the Census of Occupations: D. C. Jones.

Institution of Civil Engineers, at 8.—*Further Discussion:* Tests of Reinforced Concrete Structures on the Great Central Railway: J. B. Ball.—Corrosion of Steel Wharves at Kowloon: S. H. Ellis.—Concreting in Freezing Weather and the Effect of Frost upon Concrete: J. Hammersley-Heenan.

WEDNESDAY, December 16.

Royal Society of Arts, at 8.—Testing Pigments for Permanence of Colour: Sir William de Wiveslie Abney.

Royal Meteorological Society, at 7.30.—Distribution of Relative Humidity in England and Wales: W. F. Stacey.—Observations of the Upper Atmosphere at Aberdeen by Means of Pilot Balloons: A. E. M. Geddes.

Royal Microscopical Society, at 8.—X-Rays in Relation to Microscopy: J. E. Barnard.

Geological Society, at 8.—The Palæolithic Age and its Climate in Egypt: Prof. W. M. Flinders Petrie.

THURSDAY, December 17.

Royal Society of Arts, at 4.30.—The Indigo Industry: Dr. F. Mollwo Perkin.

Institution of Mining and Metallurgy, at 8.

Institution of Petroleum Technologists, at 8.—Notes on the Development of the Trinidad Oilfields: Prof. J. Cadman.

Linnean Society, at 5.—"Witches Brooms," caused by the Gall-mite, *Eriophyes triradiatus*, Nal., on *Salix fragilis*, illustrated by lantern-slides: M. Christy.—The Brent Valley Bird Sanctuary; An Experiment in Bird Protection: W. M. Webb.

FRIDAY, December 18.

Institution of Mechanical Engineers, at 8.

Wireless Society, at 8.—The High Frequency Resistance of Wires and Coils: Prof. G. W. Osborn Howe.

Physical Society, at 5.—Exhibition and Description of Some Apparatus for Class Work in Practical Physics: Dr. G. F. C. Searle.—A Vacuum Guard Ring and its Application to the Determination of the Thermal Conductivity of Mercury: H. R. Nettleton.

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THURSDAY, DECEMBER 17, 1914.

THE ROYAL SOCIETY OF ARTS.

A History of the Royal Society of Arts. By Sir Henry Trueman Wood. Pp. xvii+558. (London: John Murray, 1913.) Price 15*s.* net.

TO many who have attended meetings and lectures at the Royal Society of Arts during the last quarter of a century, or have been connected with its management, it will seem exceedingly appropriate that this history of the society since its inception in 1754 should have been written by Sir Henry Trueman Wood, its secretary since 1879, who, during all these latter years has been so intimately associated with all its activities that the society can scarcely be thought of by anyone without his well-known, tall, and spare figure appearing simultaneously to the mental eye.

To a large number of the public, and perhaps also to not a few members of the society itself, much of the information contained in this book will be something of a revelation. Few can know the early history of the society and the large amount of work that it performed during the latter half of the eighteenth century, while but a small number of its present-day members can be aware of its remarkable membership in early times. This included, among numerous and distinguished members of the peerage, a perfect medley of famous personages in various walks of life. For instance, we find among them Edward Gibbon, the historian of "The Decline and Fall"; Thomas Chippendale, of furniture fame; Benjamin Franklin, the distinguished American natural philosopher and politician; David Garrick, the actor; Oliver Goldsmith, the poet; Dr. Johnson, of dictionary fame; William Hogarth, the painter; Robert Adam, one of the two brothers who were the eminent architects who built the existing somewhat quaint and old-fashioned building in which the society still has its offices and holds its meetings; Sir Joshua Reynolds, first president of the Royal Academy; William Pitt, afterwards Earl of Chatham; and the notorious John Wilkes, to mention only a very few of those who are best known.

The society included in its membership all sorts and conditions of men, and interested itself in an extraordinary variety and multiplicity of matters. There does not seem to be much connection between mangold-wurzels, which the society appears to have introduced, harpoons, motive power, steel and gem engraving, naval construction, leadless glazes, medicinal plants, chimney sweeping or fire escapes, to mention just a few subjects taken at random from the long list that has been dealt with by the society at various times. Evidently the society, like Francis Bacon before it, took all knowledge for its province.

Especially interesting is the account of the large part played by the Society of Arts in the foundation of the great exhibitions of 1851 and 1862, and through these, as the author states, "of that long series of international exhibitions which have had such far-reaching influence on the arts, as well as on industry and trade."

Of great interest, also, is the chapter devoted to the society's medals, many of which are well illustrated, and, having been designed by Flaxman, the two Wyons, and other celebrated artists, are in themselves objects of beauty.

Some of the facts brought out as to various inventions are somewhat astonishing, as, for instance, that, until invented by Sturgeon—to whom the society granted in 1825 both a medal and a premium—the electromagnet, which to-day is so enormously employed in telegraphy and telephony and in almost every description of electrical plant, was unknown. Without this instrument practically no modern electrical development could have taken place. This is probably the most important invention that the society ever directly encouraged, for, as stated in the work under review, it is disappointing that the names of Watt, Crompton, Arkwright, and others are missing among those rewarded by the society.

The author says: "The best reason that can be suggested is that all these men were in advance of their time. Like all great inventors, they had to wait for recognition until they had overborne the opposition of ignorance and of rival interests, and it was then too late for prizes or contributions." Further, the society in its early years excluded all patented inventions from those eligible for premiums, continuing this practice up to about 1844, when wiser counsels prevailed and the rule was abandoned.

Another electrical contrivance of value, namely, the Smee galvanic battery, received in 1840 the reward of a gold medal, while in 1841 Robert Murray received a silver medal and 10*l.* for his invention of the now universally used method of obtaining a conducting surface for electro-deposition by means of plumbago. As recorded by Sir Henry Wood, however, perhaps in early days the society effected less by means of its medals and premiums than it did by its success in the starting of new movements. Allusion has already been made to its influence on the great exhibitions, but, as is pointed out by the author, the society also played a great part in regard to reform of the Patents Acts; in connection with artistic copyright; in the starting of mechanics' institutes throughout the country; in promoting technical education; in reference to national musical training; in regard to postal reforms; in the institution of public examinations for various purposes, and numerous other subjects of public interest.

In later years the "Cantor" and other lectures by eminent scientific men on all manner of subjects have more and more become one of the chief elements of the society's well-known usefulness.

This is made evident by the author, who also gives accounts of other of the society's manifold activities in various directions, which cannot here be mentioned for want of space.

It should be added that Lord Sanderson, G.C.B., chairman of the council of the society for the years 1911–1913, contributes an illuminating preface. A. A. Campbell Swinton.

HOUSEHOLD SCIENCE.

Physics of the Household. By Prof. C. J. Lynde. Pp. xi+313. (New York. The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 5*s*. 6*d*. net.

THE author of this book is professor of physics in the Macdonald College, an affiliated college of the McGill University, Montreal, where a school of household science is one of the branches of the institution, and it is for students of household science that the book is written. It presents the subject of physics in close relation to its domestic applications, and abounds in illustrations and examples of household appliances and processes. It should be of great use to science teachers, especially those who have to teach girls, in reminding them of the range of familiar things and topics of physical interest that lie in the home environment, and that often lie unheeded and unexplained.

The suitability of the book for students themselves is, perhaps, more open to discussion, and it is more than likely that it will come under the censure of teachers who are wedded to the conventional form of text-book. The chief ground of attack would no doubt be that so far as the general principles of physical science are concerned, the elucidation is cramped and obscured by the weight of illustrations of their practical application. To treat the subjects of mechanics, heat, electricity and magnetism, light and sound and their applications in three hundred pages has led to a certain breathlessness of style, and some topics are treated very vaguely.

The gaps in the knowledge of those in control of the household that are the most conspicuous and seem to call most loudly for repair, do not relate so much to the design and principles of construction of appliances, as to the conduct of operations. An increased apprehension of the application of the lever principle or of the construction and *modus operandi* of an electric bell is all to the good, but it is not to be compared with a real live knowledge of the laws of heat and the capability of thinking and acting within them in the great field of household operations to which they apply. It is extraordinary to see the woodenness with which a woman armed with the conventional "heat" of the school or college text-book will face simple problems of heating or cooling as they arise in the household. This defect is not to be repaired merely by a rational account of the principles on which heating appliances are constructed. To instil real activity of mind it is necessary to teach in terms of problems with a wide range of experimental exercises.

For the reasons indicated above, it is fair to say that the value of Prof. Lynde's book to students must depend very largely on the laboratory work that accompanies it, and on the constant raising of questions and corollaries by the teacher. This, however, is true of most text-books, and it must not lead us to undervalue one that has so large an element of originality and is so likely to be useful. A. S.

HOG-SPEARS AND FISHING-RODS.

(1) *Modern Pig-Sticking.* By Major A. E. Wardrop. Pp. xii+304. (London: Macmillan and Co., Ltd., 1914.) Price 10*s*. net.

(2) *Fishing and Philandering.* By A. Mainwaring. Pp. 254. (London: Heath, Granton and Ouseley, Ltd., n.d.) Price 6*s*. net.

(1) WHAT fox-hunting is to England, pig-sticking is to India, with the difference that the latter has that spice of personal danger from attacks on the part of the quarry which, to the regret of many sportsmen, is entirely lacking in the former. Both, too, have nowadays this in common, namely, that in their headquarters they depend to a greater or less degree on protection for their quarry—a fact which may come as a surprise to those unacquainted with India at the present day, and the great diminution in the numbers of its big game which has taken place in many districts. The headquarters of pig-sticking are the "khadirs," or river-valleys, of the Ganges and Jumna in the respective districts of Meerut and Muttra; and to old Anglo-Indians who have ridden or shot in the khadir, Major Wardrop's gossipy book will come as a delightful reminiscence of bygone days. To the newcomer in India it will serve as an incentive to rival the deeds of his predecessors in one of the most noble and exciting of all field-sports.

How well qualified is the author (aided by contributions from other hog-hunters) for his task may be inferred from the statement that he has been present, to the best of his belief, at the death of between seven hundred and eight hundred boars. To stay-at-home people such numbers may savour somewhat of exaggeration, but any such misgivings may be dispelled by reference to the final chapter of the book, where he will learn that the average annual bag of the Muttra tent-club alone is 210 head.

Major Wardrop gives his readers a glimpse of early pig-sticking by recalling the almost forgotten fact that for the first quarter of last century the universal weapon was the long throwing spear, and that the modern short "jobbing" spear did not come into use until 1830. In the penultimate chapter he discusses the paraphernalia and technique of the sport. For the contents of the intermediate chapters the reader must be referred to the book itself, which he will probably not leave until he has read it from cover to cover.

(2) An equally delightful volume is the second on our list, although it has to be confessed that its contents include more "philandering" than "fishing"; but since it teems with anecdotes which can scarcely fail to raise a hearty laugh, its appearance in these troublous times should be very welcome. Like the first, this volume will prove of interest to Anglo-Indians, as it comtains a chapter of mahsir-fishing, coupled with the author's experiences among what he is pleased to denominate Indian trout. As regards the remainder of the book, perhaps the most valuable chapter to the practical angler is that dealing with the use of shrimps as a bait, as practised in Ireland, a considerable portion of which originally appeared in the *Field*. Like most anglers who have tried their hands on fish of many kinds, Mr. Mainwaring unhesitatingly awards the palm, from the point of view of sport, to the lordly salmon, although he confesses to be no adherent to the "dry fly" mode of catching his fish. The general scope of the volume is well indicated by its title, and the author does not even touch upon the natural history side of the subject. R. L.

MATHEMATICAL TEXT-BOOKS.

(1) *Elements of Algebra.* By G. St. L. Carson and Prof. D. E. Smith. Part i., pp. v+346. (London and Boston: Ginn and Co., 1914.) Price 3*s*.

(2) *John Napier and the Invention of Logarithms, 1614.* A lecture by Prof. E. W. Hobson. Pp. 48. (Cambridge University Press, 1914.) Price 1*s*. 6*d*. net.

(3) *An Elementary Treatise on the Calculus for Engineering Students.* With numerous examples and problems worked out. By J. Graham. Fourth Edition. Pp. xi+355. (London: E. and F. N. Spon, Ltd., 1914.) Price 5*s*. net.

(4) *Constructive Text-book of Practical Mathematics.* By H. W. Marsh. Vol. iv.: Technical Trigonometry. Pp. x+232. (New York: J. Wiley and Sons. Inc.; London: Chapman and Hall, Ltd., 1914.) Price 6*s*. 6*d*. net.

(5) *Arithmetische Selbstständigkeit der europäischen Kultur.* Ein Beitrag zur Kulturgeschichte von Prof. N. Bubnow. Aus dem Russischen übersetzt von Prof. J. Lezius. Pp. viii+285. (Berlin: R. Friedländer und Sohn 1914.) Price 10*s*.

(1) THE teaching of algebra is still in the experimental stage, and is likely so to remain for many years to come. There are extremists in each camp. There are those who feel that no real progress can be made until considerable manipulative skill has been acquired, and those who hold that the real educational value consists in the absorption of certain general ideas which are largely independent of algebraic drill. The authors of this volume claim to steer a middle course. How far they have succeeded in solving the puzzling problem with which educationists are faced to-day can only be decided by trial. Certainly there are many good features in their book, which is based on the formula rather than the problem. But until an actual trial is made of their methods, it is impossible to pronounce with any certainty on the merits of their scheme, for the ramifications, affecting as they do the whole scheme of education of the nonspecialist, are particularly intricate. We shall look forward with interest to the second volume.

(2) In view of the tercentenary celebration of the publication of John Napier's "Mirifici Logarithmorum Canonis Descriptio," under the auspices of the Royal Society of Edinburgh, the issue of this small volume comes at an opportune moment. Most schoolboys have heard of logarithms and realise their practical utility; but few of them are acquainted with their history, and fewer still with the form in which they originated. Dr. Hobson gives in a simple and very readable manner a comprehensive account of their discovery and evolution; an engraving of Napier and a reproduction in facsimile of a page of the Descriptio add to the attraction of a book that should find its way into every school library.

(3) The opening chapters of this text-book contain in outline such parts of algebra, trigono-

metry, and co-ordinate geometry as are requisite for a study of the calculus. Differentiation and integration are taken separately, on ordinary lines. Applications are then made to Fourier series, moments of inertia, pressure, electricity, etc., and the concluding chapters deal mainly with differential equations and their use in physics. There is not any particular note of originality, but the treatment is good, and should enable engineering students to acquire a satisfactory acquaintance with infinitesimal methods.

(4) The aim of this text-book is to bring the subject of trigonometry into as intimate a relation as possible with those problems of modern life which are most likely to interest the ordinary student. The author believes that too much importance is attached to surveying and ship-problems and too little to technical industries. Consequently many of the questions, and a number of excellent diagrams, deal with different forms of machinery and scientific instruments.

(5) This is a German translation of a Russian treatise. It is intended to form one of a series of investigations into the early development of mathematics in Europe. The present volume deals mainly with the evolution, structure, and use of the abacus. The author has made a careful study of the writings of Gerbert, and has attempted to remove some of the many obscurities they contain. Two other volumes are promised, one dealing with the history and origin of our figures, and the other with the history of Euclidean geometry in Latin civilisation.

BY-WAYS OF MEDICINE.

(1) *The Ileo-Caecal Valve.* By Dr. A. H. Rutherford. Pp. vi+63. (London: H. K. Lewis, 1914.) Price 6*s.* net.

(2) *I.K. Therapy: with Special Reference to* Tuberculosis. By Dr. W. E. M. Armstrong. Pp. x+83. (London: H. K. Lewis, 1914.) Price 5*s.* net.

(3) *Clinical Examination of the Blood and its Technique: a Manual for Students and Practitioners.* By Prof. A. Pappenheim. Translated and adapted from the German by R. Donaldson. Pp. viii+87. (Bristol: J. Wright and Sons, Ltd., 1914.) Price 3*s.* 6*d.* net.

(1) THE contents of this book constituted a thesis for the M.D. degree submitted to the University of Edinburgh. The term ileo-cæcal valve is applied to the orifice between the small and large intestines and the anatomical structures immediately adjacent and intimately concerned with this orifice. The author shows that divergent views have been expressed regarding the form and structure of this valve, divergences due partly to the method of preparation of the specimens and partly to variations in the valve itself. From an examination of a living subject, and from a series of thirty-two specimens removed soon after death and suitably treated, the author believes that he is able to describe the normal appearance of the valve, the function of which is to regulate the flow of semi-fluid bowel contents through the orifice and to prevent regurgitation. The book is illustrated with coloured diagrams and a number of excellent half-tone plates.

(2) "I.K." therapy has been evolved as the result of many years' labour by Carl Spengler, of Davos. It is chiefly directed against tuberculosis, but is being extended to other bacterial infections. The exact details of the preparation of the remedy have not been published, but the principle employed is the immunisation of a rabbit by means of intra-muscular injections of tubercle virus. The animal is then bled and the *whole* blood (not the serum only) is taken, laked, and high dilutions are prepared, it may be up to one hundred million. Spengler maintains that the red-corpuscles are carriers of the immune substances to a degree far exceeding that of the serum. These immune bodies ("Immunkörper," hence the title "I.K.") are the active therapeutic constituents. They possess partly lytic or solvent action on the tubercle bacillus and partly antitoxic or antidotal action against the tuberculous toxins.

The author describes in detail the above considerations and discusses the treatment of tuberculosis with I.K. serum. As regards the results obtained with it, the statistics are few and incomplete, though those who have employed it claim that cure of pulmonary consumption may be anticipated in all but the most advanced cases. Unfortunately, in estimating the gravity of a case of pulmonary consumption, it is impossible to allow for the extraordinary spontaneous improvement and recovery which sometimes occur in these patients, and more or less selection, in some instances unconscious, is practised by the physician, so that we believe that the only true test of *any* form of treatment lies in treating alternate cases only of a long series—a mode of trial which has yet to be applied to tuberculin and all other forms of treatment.

Dr. Armstrong has given a very useful summary for those who may desire to apply I.K. treatment, and has also included details of some beautiful staining methods for the tubercle bacillus and of the precipitin reaction for the diagnosis of tuberculosis which have likewise been devised by Dr. Carl Spengler.

(3) This little book, while forming a useful guide to the clinical examination of the blood, contains little that cannot be found in several well-known manuals on this subject. The only novelty, in fact, which we notice in it is the particular technique employed by Prof. Pappenheim. In some respects, indeed, it is lacking. Thus we find no mention of a common method of enumerating the leucocytes by an examination of microscopic fields in the preparation employed for a red-cell count, and there is no connected account of the blood-picture of pernicious anæmia and of the leukæmias. The nomenclature of the blood-cells and their variations is also unusual and difficult to follow by those accustomed to British nomenclature. In some respects the book is interesting reading, *e.g.* Prof. Pappenheim's views on the derivation of the leucocytic cells. The book contains two beautiful coloured plates of the blood-cells and numerous figures in the text.

R. T. HEWLETT.

OUR BOOKSHELF.

The Annual of the British School at Athens. No. xix. Session 1912–1913. Pp. viii + 314. (London: Macmillan and Co., Ltd., 1914.) Price 25*s.* net.

THE most valuable contribution to this issue of the annual is the report by Messrs. R. M. Dawkins and M. L. W. Laistner on the famous Kamares Cave in Crete. This has been known for more than twenty years as a prehistoric sanctuary, but its complete investigation was carried out only in 1913 under the auspices of the British School at Athens. The early fame of the cave was due to the discovery in the early 'nineties of a number of vases and a few figurines. The work has now been successfully accomplished under considerable difficulties. The general result is that the votive objects which form so striking a feature of other caves and mountain sanctuaries in Crete —the libation tables of Psychro, the shields and bronzes of the Idæan cave, and the figurines of Petsofá—are conspicuously absent. The question then arises whether the Kamares Cave was really a sanctuary or only a shelter. The writers conclude that its position renders its use as a shelter improbable; the finds themselves, if they do not positively suggest a sanctuary, equally negative the idea of a dwelling, because houses of the Bronze Age in Crete invariably yield obsidian, while not a single flake was found in this cave. The pottery, again, does not suggest domestic uses. On the other hand, the restricted range of the pottery shapes suggests a sanctuary in which votive vessels were deposited. The cave, in short, was probably a sanctuary of the tutelary divinity of the mountain.

Another side of the subject is illustrated by a report in the same issue of the Journal by Dr. J. Hazzidakis, of an early Minoan sacred cave at Arkalokhori. Here some interesting vases were unearthed with remarkable bronze swords or daggers. Double axes, undoubtedly symbols of the deity worshipped by the Cretans in the prehistoric period, lead to the conclusion that during the whole of the long period of the Bronze Age, the Minoan periods of Sir A. Evans, the Cretans practised one and the same cult, and this is as much as to say that they were, all through, one and the same people.

The Fauna of British India, including Ceylon and Burma. Edited by Dr. A. E. Shipley, assisted by G. A. K. Marshall. Orthoptera (Acridiidæ). By W. F. Kirby. Pp. ix + 276. (London: Taylor and Francis, 1914.) Price 10*s.*

THE lamented death of Mr. W. F. Kirby left his memoir on the locusts of British India not quite completed. So far as completion was possible it has been effected by the kind offices of Mr. C. O. Waterhouse, who has compiled many of the diagnostic keys. The memoir, which is an admirable piece of systematic work, deals with no fewer than 329 species of Acridiidæ.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Wet Bulb Temperature and Climatology.

IT is rather disappointing to find, according to your report of the proceedings of the Section of Physiology of the British Association, the discussion upon climate had to be abandoned because no one was prepared to follow up Prof. Osborne's contribution to it. For the points raised by Prof. Osborne, according to what we gather from your short report (p. 322), are of great and vital interest. He emphasises the importance of the readings of the wet-bulb thermometer as indications of what one might call the evaporative quality of the atmosphere as it affects the economy of the human body. Unfortunately the wet-bulb thermometer is untrustworthy for several reasons, and it is well known that physicists treat it with scant respect. Its indications depend in an uncertain way on the physical condition of the air surrounding it, and no one has been able to give a satisfactory method of deducing from its readings the value of the vapour pressure of the atmosphere. Recent experiments of ours with the Kata thermometer prove beyond question that the rate of evaporation from the skin depends directly on the defect of the actual vapour pressure in the surrounding air from the vapour pressure in contact with the skin, and the value of the air vapour pressure can be determined very easily by means of a couple of readings of the dry and wet Kata thermometer.

In order to investigate fully the relation between the climatological condition obtaining in different parts of the United Kingdom and the cooling and evaporative power of the air as measured by the Kata thermometer, we would welcome the help of volunteers in town and country districts, who would take daily readings with the Kata thermometer, according to directions accompanying each instrument, which we would supply. The time for taking an observation need not be more than five or six minutes. Full details of the Kata thermometer, its construction and use appear in Dr. Hill's Report of Ventilation recently published by the Local Government Board. If any of your readers are interested enough in the matter to take these readings we should be glad if they would communicate with us.

Leonard Hill.
Martin Flack.
O. W. Griffith.

London Hospital Medical College,
London, E.
December 7.

Forests and Floods.

In the issue of July 16 Nature published a letter on the above subject in which I showed that pulverised soil holds more of the rainfall than the same soil after it is consolidated by time and rainfall, and it was pointed out that trees by the growth of their roots prevented the consolidation of the soil, and so enabled forest lands to retain more of the rainfall than undisturbed ground.

In that letter it was mentioned water passed more quickly through consolidated soil than through the same soil after it is pulverised. I have recently had an opportunity of observing how this peculiarity of dry soil acts in its disposal of the rainfall. In this district we had a very dry autumn; there was only 0·43 of an inch of rainfall in the 37 days extending from September 18 to October 24. The soil in the part of the garden to be referred to is of a light and sandy nature, and became very dry, though the plants seemed to get enough moisture for their requirements. The soil at the surface and to a depth of at least one foot seemed to be very dry. Before the end of the drought there were some cold nights, and the surface began to look more moist; this would probably be caused by the condensation of the rising vapour in the cold surface soil. When the rain began on October 25 the surface was thus in a good condition for absorbing it, and as the rainfall was never at any time heavy, and was well distributed over the eight days, during which 1·5 inches fell, none of it would run off the surface, as even during very rapid rainfalls the water easily enters that light soil. A day or two after the rain had ceased I was putting in some bulbs in the border, and was much surprised to find that below a depth of a little more than 3 inches of damp soil all underneath was as dry as it was before the rain began; while I find from tests made with soil lifted from the border, dried and broken up, that 1·5 inches of water wetted it to a depth of 6 inches. It was shown in the previous letter that pulverised soil holds a good deal more water than thoroughly wetted consolidated soil, so that the border was only moistened by the rainfall to one half the depth it would have been if all the rainfall had been retained by the upper layer of soil. The water evidently had not gone uniformly through the soil, but had made drainage tubes at certain places through which it had passed underground, leaving parts of the soil dry. This we might expect to happen if the soil was not easily wetted, or there were certain parts where the soil was more prepared to take water than at others. Such parts we might suppose to be those up which the water vapour rose most freely, and would therefore be damper, or the water may have escaped down the outsides of the roots of the plants. Now in well stirred soil there are none of these preferential routes for the escape of the water.

In illustration of these preferential routes one might point to the condition of the soil on vertical cuttings which one sometimes sees where roads are cut through banks, or on any deep cutting made in soil. It will be noticed that these cuttings have no vegetation on them, and that the soil gradually weathers away, leaving an overhanging turf. It will be noticed that the soil on the face of the bank under the turf remains dry, all the summer at least, however heavy the rainfall. The water evidently does not percolate straight to the soil underneath, but takes a preferential route, backwards from the turf, and downwards behind the dry soil. The dry soil seems to reject the water, which prefers to pass through the damp soil behind it. It was noticed at the end of November this year that these banks were still dry though 6·4 inches of rain had fallen since October 25.

Some soils seem to have very little affinity for water, and act very much in the same manner as most substances do towards mercury. For instance, when one watches the seashore on a calm sunny day while the tide is rising one often sees all kinds of dry particles which are much heavier than water floating on the surface; these particles may be sand or other earthy matter. Again, when walking over bare sandy soil one sometimes sees a curious illustration of this objection of dry sand to being wetted. If the weather has previously been very drying and there comes a shower of rain, some of the little hollows in the sand will get full of water, and retaining it as well as if they were made of puddle clay. Of course these cups are very shallow, otherwise the hydrostatic pressure would be sufficient to break the water film between the grains of sand.

However, repulsion of the water by ordinary soils does not seem to explain the passage of the rainfall through the soil without wetting it equally. A small clod of soil from the border referred to was dried, after which it was placed in a shallow vessel in which was less than 1 mm. of water. The clod quickly absorbed the water, raising it to its top surface, which was fully 1 cm. above the level of the water.

It is difficult to explain this preference of the water for certain parts of the soil, where the soil wets so easily on contact with it. Is it possible that the water by sinking a little deeper at certain places comes to exert a kind of negative hydrostatic pressure, and so draw the water from the surrounding area? This, if once started, would have a gradually increasing influence owing to the increasing "head."

The border referred to was opened up at a number of places on November 23, after nearly 4 inches of rain had fallen, and even then there were parts of the soil quite dry a few inches below the surface. It is evident that something is still required to explain these preferential routes of the water in dry consolidated soil. There are none of them in pulverised soil, and this points to the probable advantage in "dry farming" of stirring the soil to a sufficient depth to retain the whole of the rainfall, in addition to the usual practice of stirring the surface soil after rainfall to form a mulch to check its loss by evaporation.

John Aitken.

Ardenlea, Falkirk, December 5.

On an Apparently Distinctive Character of the Genus Bufo.

On p. 38 of Mr. G. A. Boulenger's valuable work on the "Tailless Batrachia of Europe" it is stated of the vertebral column of the Anura that "In those forms in which the vertebræ are procœlous the eighth is biconcave; the ninth being invariably biconvex." The same statement appears in the "Amphibia and Reptile" volume of the Cambridge Natural History, published some four years later (1901).

So far as I am aware, exception has never been taken to this statement. When, therefore, last year, I had occasion to examine the vertebral column of an Indian toad, *Bufo melanostictus,* I was surprised to find that the eighth and ninth vertebræ were not as described, but that, on the contrary, both were procœlous, resembling in this the seven preceding vertebræ.

At first I supposed that this was merely an abnormality resembling the condition found by Lloyd Morgan in *Rana temporaria* in 1886, and recorded by him in these columns (vol. xxxv., p. 53). I examined, however, five other specimens of *B. melanostictus* and also two of *B. andersonii,* and discovered that, in every case, all the vertebræ were procœlous, exactly as in my first specimen.

I could only come to the conclusion that, in these two species at least, we had exceptions to the rule laid down in the works quoted. On my return to England, therefore, I took an early opportunity of consulting Mr. Boulenger upon this point, who very kindly permitted me to examine a large collection of skeletons of Bufo.

Including my own specimens, more than fifty vertebral columns were examined, these belonging to some forty different species of Bufo, and it then became apparent that what I had been disposed to regard as an exceptional state of affairs, obtaining in a couple of Indian toads, *was actually an invariable condition, and, moreover, one apparently diagnostic of the genus Bufo,* for not a single specimen showed either an amphicœlous eighth or a biconvex ninth vertebra. In every case the centrum of the ninth vertebra, although hollow in front, has, of course, the usual double convexity behind.

GEO. E. NICHOLLS.

Zoological Department, King's College,
London, W.C.

A Lunar Halo.

A REMARKABLE coloured halo forming a complete circle about the moon was witnessed by me on Wednesday evening, December 2, at 7.15, my position being in North Shields. I am seventy-nine years of age, and never saw anything similar—that is, encircling the moon. It only lasted about seven or eight minutes. I am wondering if anyone else took much notice of it.

An entire ring and colours were distinctly visible. The inner part—that is, to the commencement of the halo or rain-circle—had a remarkably globular appearance, with the moon as an apex, and was the most prominent part of the phenomenon.

The moon at the time was very bright, but shining through light fleecy clouds at a great height; then the yellowy appearance commenced as shown, terminating with a dark orange rim.

The altitude of the moon would be about 60°, direction S.E., wind W.

THOS. TODD.

26 Percy Square, Tynemouth, December 5.

COLLOIDAL CHEMISTRY IN RELATION TO INDUSTRIES.

I.

WHEN the development of some branch of science reaches the stage at which a separate literature with its own terminology begins to grow up, the question of its practical utility or its value to the arts begins to be asked. Whether research has to justify itself by such directly or indirectly useful results is at least arguable, but it must be admitted that the question is particularly natural when raised in connection with a discipline like colloidal chemistry which is concerned, *inter alia,* with substances such as form the raw materials or the products of important arts, many of which, like ceramics, dyeing, tanning, the making of bread and of fermented liquors, are as old as history.

Where industries have empirically reached a high degree of perfection, the chief function of science is to provide the explanation of processes which are the outcome of experience, generally with the result that improvements become possible which experience alone cannot suggest. In judging a new branch of chemistry it is too often overlooked that even inorganic chemistry has largely played this part and has not yet quite succeeded in it in some respects: thus the theory of a process as important and familiar as the lead chamber process of making sulphuric acid is still highly controversial. On the other hand, organic chemistry provides many instances of the opposite way in which science may assist industry: by producing new bodies the properties of which are anticipated on theoretical grounds.

While, therefore, too much must not be expected of a science as young as colloidal chemistry, there is no doubt that it is destined to be of considerable value to a great number of industries in both the directions indicated above. Probably the most convenient method of showing this will be to state, without undue technicalities, a number of fundamental propositions which have now been firmly established and to illustrate their bearing on industrial processes and problems.

There is an immense amount of material to prove that the physical properties of a body may be varied continuously between wide limits by simply altering the size of its particles present or—as it is technically called, "dispersed"—in another medium, below a certain maximum limit. This is strikingly the case with the most obvious property, colour: thus, colloidal gold can be obtained red, purple, blue, or green in solutions containing the same amount of metal, and silver solutions of the same concentration may range from colourless through yellow, red, and purple to blue. Colourless or slightly coloured substances, *e.g.* sulphur, may form brilliant blue solutions. Solid colloidal solutions are also known to exist, examples of which are ruby glass, coloured by gold or copper, and the blue rock salt occurring at Stassfurt, which is coloured by metallic sodium.

The possibility of obtaining colour by dispersing a colourless substance in a colourless medium has been suggested as an explanation of the striking tint of a very puzzling class of bodies, the artificial ultramarines. Their chemical composition is very uncertain, but none of the compounds of which they are a mixture are at all likely to be blue. Moreover, the ingredients used can, on one hand, be varied considerably without affecting the colour, and, on the other, batches of exactly the same composition may vary in colour from the desired blue to a greenish-white owing to variations in the process of fusion. The suggestion has been made, and supported by a good deal of evidence, that these variations may be due simply to differences in the "degree of dispersity," *i.e.*, in the size of the particles of one constituent disseminated through another. The same explanation has been tentatively put forward by Wo. Ostwald to account for the peculiarities of a very interesting group of dyes, the sulphide dyes—peculiarities which are not easily accounted for by their constitution alone.

It is, of course, well known that certain inorganic pigments, obtained by precipitation, vary in colour according to the concentrations and temperatures of the reacting solutions: thus, cadmium sulphide may be any shade from salmon pink to golden yellow. The reason is again to be found in the different size of the particles of precipitate which—up to certain limits—tends to increase with decreasing concentrations. There is a possibility of still further reducing this size with resulting changes in tint and incidentally with an increase in covering power, by adding to the solutions extremely small amounts of some organic colloids like glue or casein—a procedure which deserves extensive investigation by those interested.

Among the most important and most exhaustively investigated properties of colloids are their electrical characteristics. To describe these as briefly as possible, we may say that finely divided substances in contact with water and a few other liquids become electrically charged. In the majority of cases the charge is negative, but the oxides and hydroxides of a number of metals and a few dyestuffs are positive. The amount and eventually the sign of these charges can be modified by the addition of acid or alkali: thus, negatively charged particles become more so in alkaline media, while acid in increasing amounts diminishes and finally neutralises negative charges. Both these effects find technical application: thus, very fine precipitates or slimes which obstinately refuse to settle in neutral or alkaline liquids come down rapidly if the latter are made acid. The effect of acidity is to neutralise the negative charges on the particles, and their mutual electric repulsion, which helps largely to keep them in suspension. On the other hand, the addition of alkali to clay slip (the particles of which are also negative) has the opposite effect of suspending or "dispersing" the particles, so that the slip loses its plasticity and can be cast in moulds, a procedure which is employed on a large scale.

Owing to the charge on particles in contact with a liquid—which, as need scarcely be said, assumes the opposite charge—a relative movement of the two phases takes place in an electric field, that is, when electrodes connected to a source of current are immersed in the liquid. If the particles are freely suspended, they move towards the electrode having the opposite sign; if, as is sometimes the case, the solid is aggregated into a porous diaphragm, the liquid flows through the diaphragm towards the other pole. To take a concrete example: particles of carbon are negative and therefore travel towards the positive pole or anode; if they are formed into a fixed diaphragm, for instance, a plate of porous carbon, the water—which is positively charged—flows through this diaphragm to the negative pole or kathode. The movement of particles in the electric field is called cataphoresis; the flow of liquid through a diaphragm electro-osmosis. Both phenomena have been applied industrially by Count Schwerin. Thus, clays can be freed from iron oxide by being suspended in water in an electric field, since clay particles are negative while iron oxide is positive, so that the two substances travel to opposite electrodes. Spongy substances having a cellular structure, like peat, can be freed from water by being placed between a perforated plate acting as kathode while a second plate resting on the peat serves as anode. The solid being negative, the water is positive and flows to the kathode, escaping through the perforations in the latter. Both processes are capable of varied and extensive applications, many of which are being developed.

It is highly probable that electric factors play a considerable, although by no means clear, part in the various processes for separating sulphide ores from gangue with the aid of oil, particularly in the Minerals Separation process, which consists in adding to a slightly acid pulp made from the ore, part of which must be exceedingly fine, a minute quantity of oil and agitating in such a manner that a considerable quantity of air becomes mixed with the liquid. As soon as agitation ceases the air rises in the form of bubbles which carry the sulphide to the top, while the gangue sinks to the bottom. The necessity for acid reaction, in conjunction with known differences in the electrical properties of oil, quartz and air surfaces in contact with acid water, is strong evidence that the electrical properties of suspended particles play an essential part in the process, and its future investigation will have to take them into account to a much greater extent than has been the case up to the present.

Our knowledge of the effects of the two factors discussed so far—size and electric state of particles—has been gained through the study of colloidal solutions, chiefly of metals and sulphides, *i.e.*, of suspensions in which the diameter of the particles lies below the limit of microscopic visibility, roughly speaking, below 200 $\mu\mu$ (1 $\mu\mu$ = one-millionth millimetre). While the preparation of such solutions is of the greatest theoretical interest, and some are used therapeutically, they have found only a few technical applications worth mentioning.

E. HATSCHEK.

"FIELD-WORK" WITH THE BRITISH ASSOCIATION IN AUSTRALIA.

IN connection with the recent visit of the British Association to Australia, in addition to presidential addresses and evening discourses and the more formal sectional proceedings, all of which have now been fully recorded in NATURE, much good scientific work, especially in connection with the natural history sciences, was carried out by means of special meetings, expeditions, and discussions of a more or less informal character, kindly and wisely arranged by the local men of science for particular groups of the over-seas party. Moreover, on the visits paid to university laboratories, museums, and other institutions by many of the party, problems for investigation were pointed out, and plans for future research and cooperation were suggested, of value to hosts and guests alike; and it is not improbable that some of these informal conferences may have as great an effect upon the advancement of science in Australia as any of the more public meetings of the Association.

It is impossible to enumerate all the opportunities for useful work thus given to the visiting men of science, but a few of the leading occasions that were made by the Australian naturalists for bringing biologists and geologists into direct contact with the problems of wild nature may be here briefly indicated. Some of these informal expeditions and discussions, it may be added, led to the appointment of Australian research committees, to which grants were given by the British Association Committee of Recommendations meeting at Sydney on August 25.

The week or more spent by members of the "Advance Party" in Western Australia was almost wholly devoted to work in the field, both on land and water, and Prof. Dakin, one of the local secretaries and leader of the zoological excursions to the Yallingup Caves and Mundaring Weir and a dredging expedition on the Swan River, has already given some account of this field-work in NATURE for September 24. But in addition to these larger parties, groups of zoologists and others were taken on occasions to visit points of interest on the Darling Range and elsewhere, where Peripatus (*Peripatoides gilesii*, Spencer) and other rare and interesting organisms were to be found. Of scarcely less interest to zoologists and anthropologists were the discussions which resulted from visits to the collections at the Perth Museum under the direction of Mr. B. H. Woodward and Mr. Alexander, and to those at the University made by Prof. Dakin on his recent visit to the Abrolhos Archipelago (the subject of a communication to Section D at Sydney). Throughout the visit to Western Australia, although no formal sectional meetings were held, the conferences with local men of science at the University, the Museum, and in the field, dealt largely with questions of local research, and may confidently be expected to result in further investigations.

During the time of the Adelaide meeting a party of geologists and chemists visited the celebrated Broken Hill mines and the smelting works at Port Pirie for the purpose of studying the occurrence of the ores and the methods employed in working and smelting. Another party of geologists, led by Mr. W. Howchin, the discoverer of the local evidences of glaciation, at the same time visited the Sturt River to examine the Cambrian glacial beds, and also explored the Permo-Carboniferous glacial beds and the Archæocyathine lime-stones of Hallett's Cove, and finally the granitic rocks of the southern sea-coast in the neighbourhood of Victor Harbour. Several small bands of zoologists made observing and collecting trips from Adelaide to Lake Alexandrina, Victor Harbour on the coast, the Mount Lofty Range, and elsewhere, at all of which localities objects of interest were seen and material collected which may lead to research in the future.

One of the most interesting excursions from Adelaide was that arranged for the anthropologists, by Prof. Stirling, to Milang, on Lake Alexandrina, for the purpose of inspecting a number of men, women, and children from the Mission Station, including some full-blooded aborigines. These gave displays of dancing, boomerang-throwing, hut-building, and basket-making, and some of the British Association party collected information in regard to cat's-cradle games and native genealogies.

FIG. 1.—Black swan on nest in a river of S. Australia.

Interesting botanical excursions were arranged from Adelaide by Prof. T. G. B. Osborn, one to study the Salicornia scrub and the mangrove swamps of the coastal region, one to various localities on the Mount Lofty Range to see the fern gullies and the scrub of the higher regions, and a third to Mannum, on the Murray River—all of ecological interest.

At Melbourne the time and attention of over-seas members were naturally more fully taken up with the formal programme of sectional meetings and addresses in the city, but during the week-end various opportunities were made for exploring the natural history of the neighbourhood. The geologists were taken to Macedon to examine the alkaline igneous rocks, and to Bacchus Marsh for the Permo-Carboniferous glacial tills lying upon striated surfaces of still older rocks. Other groups of geologists were taken to Ballarat and to Bendigo. Parties of zoologists and botanists under the guidance of Prof. Ewart and others, were taken through fine scenery to various points of interest, such as Marysville, Emerald, the National Park at Wilson's Promontory, Warburton and Cement Creek, to see the celebrated big-tree country and the tree-fern gullies. But here, again, it must be remarked that a large number of smaller trips were made by experts for special purposes under private guidance, resulting in consultations between the local scientific men and their European guests.

From Sydney there were excursions of very general scientific interest to the Blue Mountains, which afforded the geologists the opportunity of studying the leading features of the geological structure of New South Wales and of the remarkable elevation, which this, in common with many other parts of the continent, experienced in Tertiary or Post-Tertiary times. These excursions were also extended to the Jenolan Caves, which are typical, but very magnificent, examples of stalactitic caves in limestone of Silurian age. Amongst other interesting features were seen the remains of an aboriginal skeleton in one cave and of a wallaby's bones in another embedded in the stalagmitic floor. Other geological excursions to West Maitland and Newcastle gave an opportunity of examining the productive coal measures of the colony. The Blue Mountains and Jenolan expeditions were, however, of interest also to zoologists and botanists, who were enabled to study in their native haunts such rare and interesting forms as Peripatus and land Planarians, and to see many of the characteristic birds and insects of the country. Other excursions from Sydney were naturally rather of a marine biological character. Prof. Haswell and Dr. S. J. Johnston organised a collecting party, which visited various parts of Port Jackson in a steam launch in order to explore the wonderfully rich invertebrate fauna exposed at low tide. Another opportunity was given by Prof. Haswell to a small party of zoologists to collect choice material from one of the islands in the harbour.

In connection with the marine fauna the question of more fully exploring the Australian fisheries was under consideration at several centres, and it seems probable that a more thorough investigation of the coastal waters and their contained plankton by modern oceanographical methods will be undertaken at an early date. Another outcome of informal conversations was the resolution, brought before the Committee of Recommendations for adoption by the Council of the Association, welcoming the project to convert a portion of Kangaroo Island in Southern Australia into a Government reserve for the protection of the fast-disappearing native land fauna.

From Sydney a number of smaller informal excursions were arranged by Prof. Lawson for the purpose of studying the botany of the Port Jackson neighbourhood, including the National Park. Another important botanical excursion, under the guidance of Mr. J. H. Maiden, visited the Bulli Pass and the Burrinjuck Dam, passing through interesting country and a rich fern vegetation.

Queensland, like Western and South Australia, was felt to be a centre for work in the field rather than for sectional meetings and discussions. The expeditions from Brisbane included the gold and copper mines of Mount Morgan and the Gympie gold field, and, also for geologists, those to the Glass-house Mountains, a series of Trachytic volcanic necks rising abruptly from the plain (see Fig. 3), and to Ipswich to examine the Trias-Jura coal measures and associated volcanic rocks. Zoologists, along with botanists, were given interesting opportunities of seeing and collecting the characteristic plants and animals both from cultivated and wild country on the expeditions to Nambour, the Blackall Range and the Maroochy River, Cleveland, Bribie Island in Moreton Bay, and on the expedition to Dr. Jean White's Prickly Pear experimental station at Dulacca. The field-work organised in connection with the section of Agriculture has already been noticed, in NATURE for November 19.

FIG. 2.—British Association party on an expedition in southern Queensland.

A good deal of research, definitely planned in relation to the Australian meeting, and resulting in some cases in papers or addresses before the sections, was carried on during the voyage out by some members of the "Advance Party." On the blue-funnel liner *Ascanius* Prof. G. W. Duffield made observations on the variation in the force of gravity over the floor of the ocean, and Prof. W. A. Herdman examined and preserved samples of the plankton from the surface waters running continuously through fine nets, day and night, between Liverpool and Fremantle. Both these researches were very materially promoted by the managers of the Blue Funnel Line, who most generously fitted up a special laboratory for each of these purposes, and gave great assistance on board and other facilities for carrying on the scientific work. Some other researches were also carried out on other routes, and on the return voyages. Preliminary accounts of these investigations were given at the Australian meetings, but further results, both from the work on board ship and from some of the field work in Australia, may confidently be expected in the future.

W. A. H.

Fig. 3.—One of the "Glass-house" mountains of Queensland named by Capt. Cook in 1770, visited by the British Association in 1914.

THE HEALTH OF THE EXPEDITIONARY FORCE.

We may well be thankful that the news from the Front continues to report favourably of the general health of our men. It need scarcely be said that the labour of housing and treating so many severely wounded is colossal; and we know, all of us, that the proportion of heavily infected wounds is unhappily and inevitably high. Indeed, the wonder is, that every wound is not heavily infected: for we may be sure that no clothes, no hands, no skin, can be clean in action: we must not talk of "clean wounds," where complete cleanliness is impossible: we must only say that some wounds healed well, in spite of the conditions under which they were made.

The urgency and the frequency of the heavily infected wounds have brought all men to recognise the abiding rightness of "Listerism." There was a popular notion that "antiseptics" had been abandoned for "aseptics"; that the surgeons merely sterilised their instruments, dressings, etc., by heat, and no longer needed to use carbolic acid and other antiseptic substances; and, for a great part of the work of surgery, this popular opinion had reason. The set and formal operations, done after due preparation under conditions chosen for the patient's safety and convenience, have come to be more aseptic than antiseptic in their method—so far as it can be excusable to put the two words against each other. But, even over these formal exercises of surgery, there is room for some individualism; and the entire disuse of antiseptic agents is neither possible nor to be desired. Now, across the fine-drawn details of surgical practice in peace, and all the nicely calculated less and more of the antiseptic method and the aseptic method at this or that quiet hospital, comes the overwhelming rush of legions of gunshot wounds, many of them frightfully extensive, many left for days without sufficient treatment, and all of them more or less heavily infected.

The surface of the soil, cultivated and manured to the very utmost of its capacities, is loaded with bacteria of all sorts. Among them, are those of gangrene and of lockjaw. It is a hard fact, that the earth which our men are defending is one of their enemies: dug-up for trenches, ploughed-up by artillery fire, churned-up into mud, it provides "infective material" alike for the just and the unjust. Against these evils, Army surgeons are employing the full strength of "Listerism." Iodine, that excellent antiseptic, used in French surgery long before Lister, is coming into its own again; and the use of carbolic acid and of spirit is general and resolute. Of course, regard must be observed to the time which is lost between the infliction of the wound and the first systematic dressing of the wound; he is fortunate, who receives thorough treatment within 24 hours. Happily, against tetanus, our surgeons have the tetanus-antitoxin: it is a second line of defence, beyond the use of antiseptics. It can scarcely be reckoned on to cure tetanus, once the infection has flared up. But it can be reckoned on, with full confidence, to prevent the flaring up.

On the medical side of news from the Front, a matter of great interest is the occurrence of typhoid in the Belgian army. We may be sure that the fever is not limited to that army; and we may be fairly sure that there will be, before long, many more cases. It is, of course, the mild unsuspected cases, and the carrier cases, which are the danger. Something would be gained, if only the soldier would cover up his excrement, after the rule ordained by Moses; but he will not always take the trouble, and typhoid thus is conveyed by flies, or by direct fouling of clothes and hands and food and utensils. Enough has been talked about water-borne typhoid and milk-borne typhoid: we want more talk about man-borne typhoid.

The protective treatment against typhoid has, on the whole, met with very little opposition, and none of real authority. Certain statements of disastrous results have been inquired into, and have been found not true. Not that no ill-effects have ever followed; but these are rare. The main fact, that the protective treatment is indeed protective, has been proved past all possibility of the least shade of doubt.

That old scourge of armies and of jails—typhus fever—has long ceased to trouble our country; probably most doctors now in practice have never seen a case of typhus. It may appear, some day, a most unwelcome visitor, in the western theatre of the war. It is conveyed by body-lice. It is said to be endemic in Silesia. It may find its way westward: or a trace of it, amid the desolation and wreckage of Belgian villages, may flare up into widespread trouble. Happily, the vigilance, the incessant zeal, of all branches of the Army Medical Service, and of all the many societies working at the Front for the welfare of the Army, will continue to bring forth good fruit. It is not possible, with such splendid organisation, such generous devotion, that any grave outbreak of infection should pass neglected; and, when the medical and surgical history of the present war comes to be written, it will be a fine record of good work accomplished on a grand scale.

STEPHEN PAGET.

THINKING ANIMALS.[1]

ABOUT ten years ago it became known that "Clever Hans," an Arab stallion owned by a Herr von Osten in Berlin, was able to answer arithmetical and other questions, tapping out the reply with his fore-foot. Notoriety led to heated controversy, and the appointment of committees to investigate. The second of these, under Prof. Stumpf, resulted in Pfungst's book, explaining everything in terms of signals consisting in slight movements made unconsciously by some person present knowing the answer. This seemed to have solved the problem finally until the appearance of Krall's book in 1912. The author, a wealthy jeweller of Elberfeld and friend of von Osten's, had after the latter's death continued to experiment, obtaining results which, he claimed, refuted Pfungst's explanation. This claim found support in a report signed by the zoologists, Kraemer, Sarasin, and Ziegler, asserting that signalling was excluded since correct answers were given even when none of the human participants was visible to the animal. The opinions expressed on Krall's book vary from that of Prof. Dexler—"a shameful blot on German literature," to that of Prof. Ostwald, who foresees that it will "as clearly mark the beginning of a new chapter in the doctrine of man's place in nature as Darwin's chief work did in its day."

As to the problem itself, a definitive solution could result only from a free and impartial testing of the animals; as it is one can only indicate probabilities. Intentional deceit is almost certainly too simplicist an explanation, and is in any case inadequate. On the other hand, the probability of obtaining correct answers by chance has been underestimated in view of the number of unsuccessful attempts and the greater frequency with which certain numbers occur. Very much must be allowed for this and other weaknesses of testimony, the demonstration of which has been one of the successes of applied psychology, but which, as every newspaper now shows, are seldom given weight in practice. They particularly affect some at least of the would-be crucial tests. Nevertheless much remains, of which the following main explanations have been offered.

The answers are evidence of mathematical intelligence. This, although a highly developed "number-sense" has been found in persons of low general ability, and even in the feeble-minded, conflicts with all that we know from other sources about the animal mind. Detailed scrutiny of Krall's account of his teaching shows that the problem often *could* not have been understood from his exposition. Again, the correcting of a single false figure is done quickly and certainly, as might be expected if signals were being given, since these would be facilitated by concentration of the signaller's attention; if the errors are mistakes of calculation it is odd. Finally, the inability of the animals to prove their understanding by action, compared with their eloquence in the language of taps, is extremely suspicious.

The answers are due to memory. The horse's memory is, no doubt, excellent for some things, and the theory has advantages, but also serious difficulties. To associate eight taps with one symbol and nine with another, the horse must be able to distinguish the two series. But it seems probable that animals cannot distinguish numbers beyond four or five. Rothe trained his dog to come only at the fifth whistle—but this only if the whistles were at regular intervals: his horse would take four lumps of sugar in preference to three, but confused four and five. Again, the horse's eye, while very sensitive to movement, is probably unsuited to the clear perception of complex visual forms such as written numbers, and, as a matter of fact, the animals seem to attend to the questioner more than to the blackboard. Finally, the mistakes in cube root, etc., questions strongly suggest the use of tips.

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[1] (1) "Das Pferd des Herrn v. Osten (Der kluge Hans)." By O. Pfungst. (Leipzig: J. A. Barth, 1907.)
(2) "Denkende Tiere." By K. Krall. (Leipzig: W. Engelmann, 1912.)
(3) "Ueber den dermaligen Stand des Krallismus." By Prof. H. Dexter. Reprint from *Lotos*. Prague, vol. lxii., 1914.
(4) "Gibt es denkende Tiere?" By Dr. S. v. Máday. Pp. x+451. (Leipzig: W. Engelmann, 1914.)
(5) "Das Problem der Elberfelder Pferde und die Telepathie." By Prof. H. v. Buttel-Reepen. *Naturwissenschaftliche Wochenschrift*, 1914, No. 13.
(6) "Meine Erfahrungen mit den 'denkenden' Pferden." By Prof. H. v. Buttel-Reepen. *Naturwissenschaftliche Wochenschrift*, 1914, No. 16.
(7) "Eine Kritik der Leistungen der 'Elberfelder denkenden Pferde.'" By Prof. C. Schröder. *Naturwissenschaftliche Wochenschrift*, 1914. Nos. 21, 22.

The animals are responding to unconscious signals. Krall claims to have refuted this by "ignorant" experiments, but these are relatively few and seem all to have some weak spot. Thus Mackenzie reports that Rolf, the Mannheim dog, described a picture on a card held so that the holder could not see it; unfortunately, the picture was a red and blue cross, and there is reason to think that dogs are nearly colour-blind. Nevertheless, the fair number of "peep-hole" experiments and the case of the blind horse, Berto, seem to stamp as inadequate Pfungst's theory of *visually* perceived movements. Yet no other one mode of signal seems sufficient for all cases, while Hacker did actually get answers by moving his foot. Again, it is unlikely that the many individuals who have obtained answers should all make precisely the same unconscious movements. These difficulties disappear if we suppose the animals not to be blindly reacting to one specific stimulus, but to be interpreting more or less intelligently a general type of unconscious emotional or ideomotor expression—movement, variation of respiration, etc.—possibly always complex and varying with the individual and occasion. Both horses and dogs are notoriously sensitive to shades of emotional expression, and recent work by the Pawlow school indicates that dogs can hear sounds so faint as the beating of the heart. It is true, any theory of unconscious signalling presents difficulties. Units, tens, etc., are tapped with different feet; the spelling of verbal answers is phonetic, and *spontaneous* utterances are recorded, including a letter dictated by Rolf! Can the subconscious be credited with so much? The solution, if it ever comes, can scarcely fail to illuminate, if not the animal mind, at least that of man.

C. S.

THE REV. SIR JOHN TWISDEN.

At his great age of nearly ninety, Sir John F. Twisden, whose death was announced last week, had survived most of his time, the generation of William Thomson and Todhunter, who could give a detailed account of his life and work, very valuable in its day.

The *Times* of December 8 describes the curious revival of the dormant baronetage, taken up by Sir John late in life, but his retirement from the Professorship of Mathematics at the Staff College must have taken place much earlier than 1885, as a consequence of the Cardwell scheme, which had decreed that mathematics was no longer of any use to a Staff Officer.

How Napoleon would smile if he could hear it! The sequel has proved that the economy was fatal to efficiency, when we consider the costly blunders of the Staff in South Africa; and here we are engaged in a war the greatest in the history of the world, and it is a Mathematical War.

After one old-fashioned battle in the open, both sides have dug in, and the war has become a vast siege, where all arms, horse, foot, and dragoons, are turned into garrison gunners, as I predicted in these columns nearly thirty years ago. This was the war for which we were not prepared.

Artillery science is our great requirement. Cavalry work is turned over to the motorist, to scour the country and round up the picturesque old-fashioned Uhlan. In South Africa we see how De Wet, the redoubtable cavalry leader, is run down ignominiously by motor-cars. It had not dawned on our military intelligence to compare by a slight mathematical calculation the available energy, in foot-pounds or ton-miles, of a gallon of petroleum against the equivalent weight of oats. But here was a specimen of the sort of education given by Twisden to the Staff College in his excellent "Practical Mechanics," a book too little known, but containing what Maxwell called the gentlemanly knowledge of the subject, which no Staff Officer should be without. The first chapter of it is a liberal education in elementary gumption, cleverly disguised in what appears a very simple question of no apparent difficulty, always, however, strong enough to unhorse the unwary.

This elementary instruction is being acquired by the junior ranks at the front at a vast expense, and the young officer can say, in the words of Hamlet, "I once did hold it, as our seniors do, a baseness to be scientific, and laboured much how to forget all learning; but now it did me yeoman's service."

G. GREENHILL.

NOTES.

THE Hunterian Oration of the Royal College of Surgeons of England will be delivered by the president —Sir Watson Cheyne—on February 15, but the customary dinner in the evening will not be held.

WE regret to see the announcement, in the Proceedings of the Chemical Society, that Dr. C. R. Crymble, of University College, London, who was a fellow of the society, was killed in action on November 20.

WE learn from the *Times* that Prof. A. Van Geuchten, who was professor of systematic anatomy and neuro-pathology at Louvain University, has died suddenly at Cambridge, where he was receiving hospitality as a refugee.

PROF. C. S. SHERRINGTON, Fullerian professor of physiology at the Royal Institution, will deliver a course of six lectures at the institution on muscle in the service of nerve, on Tuesdays in January and February next.

THE President of the Board of Agriculture and Fisheries has appointed Mr. E. J. Cheney, lately one of the assistant secretaries of the department, to the office of chief agricultural adviser to the Board, and Mr. F. L. C. Floud to be an assistant secretary of the department.

PROF. T. A. JAGGAR, director of the Hawaiian Volcano Observatory, and a group of his assistants, had a narrow escape of their lives during a recent ascent of Mauna Loa. The volcano had become active, discharging large quantities of lava. The scientific party, while making an ascent to study the eruption, was caught in a snowstorm and nearly overwhelmed by snowslides almost in the path of the lava streams.

La Nature has again made its appearance—the first time since the beginning of August, when publication was suspended on account of the war, most of its staff having joined the colours, while its printers, photographers, and engravers had ceased work. The date of No. 2149 of our interesting contemporary and namesake was August 1, and that of the next issue, No. 2150, is December 12. The articles in this issue deal almost entirely with subjects relating to the present war, among them being armoured trains, the spirit of science in the time of war, Cracow, the defence of Belgium by inundations, and dum-dum bullets. We trust that an unbroken and long existence is now in store for this weekly review of science and its applications to art and industry.

THE death is announced, at sixty years of age, of Mr. W. W. Rockhill, who did some valuable scientific exploration in China and Tibet under the auspices of the Smithsonian Institution about twenty-four years ago, and was the author of several important works upon this and other Oriental subjects. In 1884, when attached to the U.S. Legation in Peking, Mr. Rockhill began the study of the Tibetan and Chinese languages, with the view of undertaking exploration in Tibet. Four years later he started from Peking, and was across the frontier in March, 1889. Though he had to abandon his intention to visit Lhasa, he carried out successfully a long journey through much unknown country, and the narrative of his expedition is described in his "Land of the Lamas," published in 1891. His second great journey, described in his "Diary of a Journey through Mongolia and Tibet in 1891 and 1892," earned for him the gold medal of the Royal Geographical Society. During the eleven months which this journey lasted, Mr. Rockhill travelled 8000 miles, surveyed 3400 miles, and crossed 69 passes, all more than 14,500 ft. above sea-level. The volume in which he describes this journey takes a notable place among serious works on Central Asia. Mr. Rockhill was the leading American authority on Chinese matters, and he was on his way to Peking, where he was going to take a new appointment as adviser to President Yuan-Shi-kai, when he was taken ill. On December 4 he was removed from the steamer on which he was a passenger to the hospital at Honolulu, where he died from heart disease.

THE issue of the *British Medical Journal* for December 5 contains a statement of the schemes for research drawn up by the Medical Research Committee for the National Health Insurance Joint Committee, and since approved by the responsible Minister. The grants in aid of medical research arise from the annual revenue accruing from the penny in respect of each insured person (payable out of moneys provided by Parliament) to be applied for the purposes of research. The total amount available for 1914 is 56,000*l*., of which 12,065*l*. has been spent on the purchase of Mount Vernon Hospital, and 7533*l*. on repairs, equipment, and salary. Administration is estimated to cost nearly 3000*l*., and the research scheme, including a provision for additional grants for laboratory expenditure, more than 24,000*l*. This leaves an estimated balance of nearly 10,000*l*., which, it is expected, will be reduced by the demands for special work needed in connection with the war. This special work is the extension of existing facilities for bacteriological investigation of infected wounds at the general military hospitals, including Territorial general hospitals, and the organisation for the adequate compilation of the medical and surgical statistics of the war. Among other subjects of medical research for which provision has been made are such matters as tuberculosis, rickets, and rheumatic infections. The research committee proposes, in order that researches carried out at different centres may be co-ordinated, to establish "special investigation committees" composed of one or more of the scientific members of the research committee, of members of the staff of the Central Institute, and of directors or workers in other research centres. The committee contemplates the publication of reports of work done upon special subjects with assistance from the research fund.

TWENTY-FIVE years have passed since the death of that eminent Russian traveller, N. M. Miklukho-Maklay. An account of his researches in geography and anthropology by Mr. N. A. Yanchuk has been translated in the December issue of *Man* by M. A. Czaplicka. He was a member of various scientific expeditions to the Canary and Madeira Islands, Morocco, New Guinea, Java, Malacca, and Australia. On his return to Russia in 1887 he commenced the preparation of a complete account of his travels, of which only one volume was completed before his death in the following year. Since then his papers have remained untouched. It may be hoped that on the conclusion of the war arrangements may be made for the publication of this valuable material. Meanwhile the bibliography of numerous papers contributed to scientific societies, which is appended to this article, will illustrate his marvellous activity and the wide range of his investigatons in geography and anthropology.

AN account of the trout or charrs of New England is given by Mr. W. C. Kendall, of the United States Bureau of Fisheries, in vol. viii., No. 1, of the Memoirs of the Boston Society of Natural History, and is rendered especially valuable by a series of seven very fine coloured plates illustrating the different species. Referring in his preface to these plates, which have been reproduced by Werner and Winter, of Frankfurt, the author says, "the paintings were made by the painstaking artist, Walter H. Rich, of Portland, Maine, of whose work the only possible criticism is it is too conscientiously true to life." The author has done his work with great thoroughness, both as regards the detailed scientific descriptions of the different species and varieties, and as regards the account of their habits and the conditions under which they are caught. The report should be equally useful to the naturalist and to the fisherman.

THE fishes obtained by the *Terra Nova* on Captain Scott's Antarctic Expedition are described by Mr. C.

Tate Regan in vol. i., No. 1, "Zoology," published by the British Museum (Natural History). Twelve of the species are regarded as new to science, four of them being new generic types. All but three of the twenty-five species collected by the expedition belong to the group Nototheniiformes, and the author gives a table (p. 26) showing in detail the distribution of this typical Antarctic group. Following the detailed descriptions of the fishes are two sections of a more general character, the first dealing with the distribution of Antarctic and Subantarctic fishes, and the second with the Antarctic continent during the Tertiary period. The author's conclusion is that neither the fresh-water fishes nor the marine fishes, whether Antarctic or South Temperate, support the theory that Antarctica has connected Australia with South America in Tertiary times, nor does he consider that the distribution of other groups of animals confirms such a view.

THE first part of a series of publications under the general title, "Beiträge zur Kenntnis der Land- und Süsswasser-fauna Deutsch-Südwestafrikas," which was published in the spring of the present year, contains some results of a scientific expedition to German South-West Africa, conducted by Dr. W. Michaelsen, of Hamburg, in 1911. At the same time Dr. Michaelsen publishes the first part of a series dealing with the marine fauna not only of the German colony but also of the whole West African coast, under the title, "Beiträge zur Kenntnis der Meeresfauna Westafrikas." A general account of Dr. Michaelsen's expedition, written by himself, is given in the former of the two works, which also contains reports on the Bryozoa by Kraeplin, the Copepoda by van Douwe, the Oligochæta by Michaelsen, the Isoptera by Sjöstedt, and the Skorpiones and Solifugæ by Kraepelin. In the volume on marine fauna the Hydrozoa and Pennatulacea are described by Broch and the Gephyrea by W. Fischer. Both publications are well illustrated with text figures and plates, and will add to the reputation as a scientific traveller which Dr. Michaelsen has already established by his reports of his earlier journeys to the Straits of Magellan and to Australia.

THE second part of vol. i. of the Journal of the Natural History Society of Siam contains a series of excellent papers and notes on the fauna of the country, and is well illustrated. It opens with the description of three new snakes, by Dr. G. A. Boulenger, and also contains the second part of a paper on the snakes of Bangkok, by Mr. Malcolm Smith, who, in a separate note, records for the first time the occurrence in Siam of that venomous species, the Indian crait (*Bungarus candidus*). The list of papers is completed by one on the birds of Bangkok, by Mr. W. J. F. Williamson, and a second, on those of the Raheng district, by Mr. C. S. Barton. In a note on the occurrence of an oily secretion in a wild ox during the "must" season, Mr. K. G. Gairdner, if we may judge from the figure he gives of its skull, appears to have mistaken a tsaine, or bautin (*Bos sondaicus porteri*), for a gaur (*B. gaurus*).

THE probable effects of the war on horse- and cattle-breeding in this country, and the measures that will have to be taken at its close to replenish our stock of horses, and at the same time to meet the great foreign demand for pedigree-cattle of all kinds which is likely to arise, loom large in the "Live Stock Journal Almanac" for 1915. Among others who write on this subject, Col. G. C. Ricardo is of opinion that in the future Government ought to buy remounts as two-year-olds, in order to help breeders. In another article Messrs. Stratton and Thomas discuss the future of cattle after the war, and point out the heavy drain that will almost certainly take place in our pedigree-stock when peace is proclaimed. Mr. Frank Webb writes to much the same effect, and suggests that in the not very distant future Russia will become a large buyer. The general opinion seems, indeed, to be that British and other pure bred stock will eventually oust the mongrel breeds from the civilised world; and, in consequence, that the prospect for breeders will ere long be of the brightest. In the matter of illustrations and in general get-up the present issue fully maintains the high reputation of this excellent almanac, which is certainly a wonderful shilling's-worth.

THE *Bulletin Trimestriel,* 1913, continues the summary of the plankton observations carried out by the International Council for the Exploration of the Sea during the years 1902–08. In this third part of the plankton *Résumé* ten groups are dealt with, the more lengthy articles concerning the Diatoms, the Radiolaria, and the second part of the Peridinidæ. In the 105 plates, most of which concern the Diatoms and Peridinidæ, the observed distribution of many important species is charted for the four quarterly cruises, distinctive symbols marking the different years of observation. In the text, so far as possible, a uniform method is preserved, the species of the several groups being discussed in relation to the seasonal horizontal and vertical range of occurrence in the different areas, the hydrographic relationships, and other points contributing to a fuller knowledge of the species and its part in the marine bionomics of North European waters. Much previous work has been incorporated, and when the magnitude of these international investigations is remembered, involving as they do the careful study of many thousands of hauls, made at some hundreds of stations more or less regularly visited during these years, and extending from the Barents Sea to the Bay of Biscay, the importance of this valuable work to marine science may be justly estimated.

THE annual report of the Royal Agricultural Society just issued is a record of a busy and successful year. The 1914 show at Shrewsbury was especially notable for the excellence of the exhibits, while the live-stock entries were, with one exception, the largest on record. Attention is directed to the cutting off of the supplies of kainit and other potash salts owing to the war. As no regular supply is to be obtained outside Germany, the farmer and the manufacturer of artificial manures are adversely affected. It is suggested that the practice of kelp burning may be revived, while Peruvian and other guanos may be used to supply the necessary potash to a limited extent. The Woburn

Experimental Station, besides carrying out the usual field trials on crops of various kinds, has tested the influence of magnesia in place of lime on a wheat crop. The value of crushed oats with separated milk as a food for young calves, both spring and autumn-born, is proved by the calf-rearing experiments begun in 1912 and still proceeding. In addition to much advisory work on the extermination of insect pests and animal parasites, the Zoological Department is conducting a research into the relation of pheasants to agriculture. The society's programme for 1915 is a full one, only a few features being omitted owing to the abnormal conditions now prevailing.

THE use of fish as cattle food has a novel sound, but it appears to be a common practice in various parts of the world. In Shetland and Iceland dry salt fish is fed to cattle, sheep, and even to horses. So long ago as 1853 Sir John Lawes carried out experiments at Rothamsted on the feeding of pigs with dried Newfoundland codfish. He found that the fish-fed pigs were fat and well ripened, and there was a very good proportion of increase to food consumed. Some recent experiments at the Agricultural College, Coimbatore, made at the instance of Sir F. Nicholson, director of the Madras Fisheries Bureau, have brought to light some further interesting facts. Mr. R. Cecil Wood, in describing the experiments, mentions that certain special cattle kept for display of strength at village festivals in Nandyal are fed with mutton, while it seems a fairly common practice to make use of bandicoots when killed by pounding them in a mortar and feeding them to cattle. In Mr. Wood's experiment two lots of heifers were fed on a dried fish diet and normal diet respectively. The animals took some little time to get used to the fish, but then ate it readily enough. At the end of six months the fish-fed heifers showed an average increase of weight of 54 lb. per head, as against 70 lb. for the normally fed animals. Although fish does not compare favourably with ground-nut so far as fattening value is concerned, it is suggested that on the coast a considerable saving might be effected by its use.

THE cultivation of rice in Spain affords an excellent example of the success attending a highly perfected system of agriculture. Most of the rice land is situated in the province of Valencia, where the cultivation was introduced at the time of the Moorish conquest. It is interesting to learn from Mr. E. J. Butler, in the *Agricultural Journal of India* for October, that many of the Oriental practices followed, and especially that of transplantation unknown elsewhere in Europe, are similar to those employed in India, and may probably be traced to the prolonged occupation of this district by an Eastern people. Although the total production of rice in Spain is the lowest of the six rice-growing countries, the yield per acre is double that obtained in Italy and Egypt, and more than six times the official figures for India. This result is due to the thorough cultivation of the fields with specially designed implements, to the system of transplantation, and the use of large quantities of suitable nitrogenous and phosphatic manures. The fear of encouraging malaria has hitherto acted as a deterrent to the extension of the area under rice in Europe, but at the recent International Rice Congress at Valencia the view was put forward that this prejudice is unfounded, provided that certain precautions are observed. If this view gains credence it can scarcely be doubted that there will be a material increase in the European production of this cereal.

THE relations between the two mineral representatives of iron disulphide, pyrite and marcasite, are further explored by E. T. Allen, J. L. Crenshaw, and H. C. Merwin in a paper in the *American Journal of Science* for November (p. 393). The formation of marcasite from acid and of pyrite from alkaline solutions is shown by experiment and also by natural occurrences. Wurtzite and zinc-blende are proved to have similar relations, the former being, moreover, the unstable form.

IN view of the rarity of fossil remains of apes and monkeys much interest attaches to the description by Dr. A. Smith Woodward, in vol. lxx (pp. 316–20, plate xliv.) of the Quart. Journ. Geol. Soc., of an form of the jaw at and near the point of insertion *fontani*, from the Upper Miocene of Seo de Urgel, Lérida, Spain. In several respects, notably in the form of the jaw and near the point of insertion of the digastric muscle and in the small size of the first molar, Dryopithecus approximates to the contemporary macaque-like genus Mesopithecus, and is therefore a primitive type.

PROF. A. C. LAWSON, at the invitation of the Geological Survey of Canada, has revisited the pre-Cambrian area of Rainy Lake, where he first demonstrated in 1885 and 1887 the intrusive nature of much of the "Laurentian" gneiss. His results are now issued as Memoir 40 of the Canadian Survey, dated 1913. The names Coutchiching and Keewatin are retained for the two series penetrated by the Laurentian gneiss, the former being free from volcanic matter, and the latter, overlying it, being largely volcanic. The second intrusive gneiss, which is later than the Seine (Huronian) sedimentary series, is now styled Algoman by the author. The influence of Prof. Lawson's original papers has been far-reaching. As recent evidence, we may mention Mr. A. L. Hall's address on the Bushveld Complex (Proc. Geol. Soc. South Africa, 1914. p. xxii.), and Mr. P. A. Wagner's account of the gneisses of Southern Rhodesia (Trans., *ibid.*, vol. xvii., p. 39).

IN the September issue of the Proceedings of the Philadelphia Academy, Mr. D. M. Barringer adduces further evidence in favour of the theory that the so-called meteor crater of Arizona, in place of being due to volcanic action, is really the result of the impact of a vast fall of meteorites. Of the occurrence at a remote epoch of such a fall there is ample evidence. One of the points on which the author lays special stress is the occurrence in the crater of large quantities of a quartz-glass, which was undoubtedly formed by the fusion of part of a bed of white sandstone occurring at a depth of about 350 ft. below the level of the plain, and not outcropping for a distance of seventy miles. This quartz-glass is stained with nickeliferous iron, which could only be of meteoric origin, and this fact, coupled with the lack of any evidence that crystalline quartz can be fused by the heat engendered during volcanic action, is regarded as conclusive testimony in favour of the impact theory. Corroborative evidence is afforded by the fact that intense heat is produced by the impact of big shells fired against armour-plating. The mass to which the origin of the crater is attributed was probably a dense cluster of iron-meteorites, which may possibly have formed the head of a small comet.

THE publications of the Norwegian Meteorological Institute for the year 1913 (Rainfall Observations and Year-book, both containing actual readings and mean values) are prepared in the usual careful way, and scarcely call for special remarks beyond those referred to in our previous issues. The year-book contains hourly and other observations at Green Harbour, Spitsbergen; the summary for 1912 shows that the yearly temperature was −10·4° C.; January, −24·4° (February −26·3°), July, 4·2; maximum, 9·9° on July 22; minimum −44·3° on March 31. The yearly rainfall (or melted snow) was 305 mm., on 124 days. The annual report shows that the success of ordinary weather forecasts, and notices for herring fisheries, was very satisfactory; storm warning telegrams are issued from Bergen. We note that Mr. A. S. Steen, formerly assistant-director, has succeeded Prof. H. Mohn in the directorship of the Meteorological Service, which position the latter held with much distinction from the establishment of the service in the year 1866.

SOME time before the loss of the *Titanic* Prof. Barnes, of Montreal, carried out a series of measurements of the temperature of the sea in the neighbourhood of icebergs, and came to the conclusion that the presence of an iceberg could be detected by a slight rise of temperature it produces in the sea-water around it In the summer of 1912 a party from the Bureau of Standards took automatic records of the temperature of the water during the patrol of the U.S.S. *Chester* and *Birmingham* in the North Atlantic, and their results are published in vol. x. of the Bulletin of the bureau. They show that the changes of temperature which occur in the sea far removed from icebergs are at least as great and sudden as those found in the vicinity of bergs, and that no positive conclusions as to the presence of bergs can be drawn from such changes. They find also that in the neighbourhood of a berg the temperature of the water is reduced more often than raised. These conclusions are almost identical with those arrived at during the cruise of the *Scotia*, sent out to the Newfoundland bank by the Board of Trade in the summer of 1913, except that on the *Scotia* small rises of temperature in the neighbourhood of bergs were more often recorded.

THE Bureau of Standards at Washington has issued a circular (No. 47) in which the tables of equivalents of United States customary and metric weights and measures are revised and brought up to date. It contains a useful series of conversion tables giving the equivalents of the metric and customary weights and measures from 1 to 999 units. From the introduction and definitions which precede the tables it would appear that for all practical and most scientific purposes the United States yard and pound are the same as those in the United Kingdom. The United States gallon (which is used for the measurement of liquid commodities only) is, however, only five-sixths of the imperial gallon, while the United States bushel (used only in the measurement of dry goods) is approximately thirty-two thirty-thirds of the imperial bushel. The bushel and gallon of the United States are not connected by the relation 8 to 1 as are those used in this country. The troy pound and the apothecaries pound are apparently still recognised in the United States as customary weights, although they have long died out in Great Britain. It may be of interest to note that the fundamental standard metre established in the United States by Act of Congress and by order of the Treasury is the international prototype metre, whereas the primary standard metre in the United Kingdom is the national prototype No. 16, which is shorter than the international metre by six-tenths of a micron.

AN important paper on the resins present in hops (*Humulus lupulus*, L.) has been published by Ö. Winge and J. P. H. Jensen in the *Comptes rendus* of the Carlsberg Laboratory (vol. ii., part 2, p. 116). It is shown that in the past a mistake has been made in considering one of the resins of hops, namely, the so-called γ-resin, as valueless; on the contrary, during the brewing process it both gives taste to the wort and helps in the precipitation of proteins. The total quantity of resins extracted from the hops by cold ether and determined by titration is an approximately accurate expression of the bitterness value of hops. Other data recorded show that the analytical methods hitherto used, which are based on the separation of the so-called soft resins from the hard resins, rest upon an insecure basis and give misleading results.

No. 4 of the Proceedings of the Institute of Chemistry contains an account of the steps taken by the institute in conjunction with the Board of Trade, the Society of Chemical Industry, and other bodies, to consider the needs of this country as regards chemicals, dyestuffs, glass, and porcelain vessels, which have hitherto been manufactured in enemy countries. A committee, which was appointed on September 22, after taking evidence, has reported that there is every prospect of the chemical glass industry being taken up and worked satisfactorily in this country provided that the manufacturers can be afforded some guarantee of permanency for their enterprise, and that they may have some reasonable assurance that at the conclusion of the war the newly developed industry will not suffer from foreign competition, hitherto made possible by economic conditions which do not prevail in this country. Several firms have stated their intention to undertake the manufacture of chemical glass ware, whilst others are already experimenting with a view of supplying porcelain, crucibles, basins, and funnels. Later, at a meeting of the council of the institute, held on October 30, it was resolved to appoint an advisory committee to conduct research on glass, to be carried out in the laboratories of the institute with a view to arrive at suitable formulæ to be freely available to manufacturers. Another committee has been formed to consider the needs of this country as regards laboratory reagents and the standards of purity necessary for such substances.

Probably the most interesting structural steel work on the new Lötschberg-Simplon Railway is the steel arch bridge over the Bietsch Valley, of which an illustrated description appears in the *Engineer* for December 11. This bridge is remarkable for the fact that it is built on a short-radius curve of only 300 metres, and also on a gradient of 22·2 per 1000. The situation is over a craggy ravine, between two tunnels piercing the spur on either bank. The arch has a span of 95 metres between the centres of the hinges and a rise from this chord of 23·79 metres. Supported partly upon this arch and partly by the masonry approach arches are two trussed girder spans. These girder spans are attached to the back of the central arch by means of pivoted expansion brackets, and this part of the design is of peculiar interest in view of the complexity of the movements arising from change of temperature and vertical and lateral loading. The three structural elements in the bridge are all rectilinear, while the bridge floor and its bracing alone are curved and continuous between the pier abutments.

The thirty-first annual issue of the "Year-Book of the Scientific and Learned Societies of Great Britain and Ireland" has now been published by Messrs. Charles Griffin and Co., Ltd. This useful reference volume is a record of the work done in science, literature, and art during the session 1913–1914 by numerous societies and Government institutions, and has been compiled from official sources. On the whole it provides a comprehensive survey of the activities of associations with which it is concerned, but we have failed to find any reference to the Wireless Society of London, the Illuminating Engineering Society, and the Historical Association. It is a pity, too, that in a volume published at the end of 1914 the extended reference to the British Association should deal almost wholly with the 1913 meeting at Birmingham. The volume, the price of which is 7*s*. 6*d*. net, deserves a place in every reference library.

Messrs. J. Wheldon and Co., 38 Great Queen Street, W.C., have just issued a classified list of books and other works on mineralogy, metallurgy and mining, geology and palæontology, and related subjects. The catalogue includes recent purchases and selections from several libraries, and it should be seen by geological bibliophiles and librarians of scientific societies

Messrs. G. P. Putnams Sons ask us to say that the price of "The Essence of Astronomy," by Mr. E. W. Price, reviewed in Nature of November 12 (p. 280), is not 10*s*. 6*d*. net as there stated, but 3*s*. 6*d*. net.

OUR ASTRONOMICAL COLUMN.

Comet 1913*f* (Delavan).—The following ephemeris is taken from the Ephemeris-Circular of the *Astronomische Nachrichten* (No. 469, 1914), being communicated by J. Fischer-Petersen and Vinter Hansen of the Copenhagen Observatory:—

12h. M.T. Berlin.

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
Dec. 17	16 20 40	−4 45·9	5·6
19	24 6	5 37·4	
21	27 29	6 27·7	5·7
23	30 47	7 17·0	
25	34 2	8 5·2	5·8
27	37 14	8 52·5	
29	40 22	9 38·9	5·9
31	16 43 27	−10 24·3	

Two photographs of this comet are reproduced in the current number of the Monthly Notices of the R.A.S. (vol. lxxv., November, 1914). They were taken on September 20 and 26 with the 3¼-in. portrait lens and 30-in. reflector of the Royal Observatory, Greenwich.

The Spanish Solar Eclipse Expedition.—The Madrid Observatory dispatched an expedition to Theodosia, in the Crimea, to observe the total eclipse of the sun on August 21. The party included MM. Ascarza, Carrasco, and Tinoco, with one or two voluntary helpers. The weather seems to have been favourable at their station, and the results obtained were satisfactory, and are briefly described in the *Comptes rendus* for November 30 (vol. clix., No. 22, p. 738). The corona is described as of a form analogous to that of minimum sunspots with polar rays a little more pronounced. Photographs of the spectra of the corona and chromosphere were successfully secured, and, in M. Carrasco's case, with special attention to the red, yellow, and green regions. While details regarding the wave-lengths will be published later, M. Carrasco directs attention to a red coronal radiation, the wave-length of which he gives as λ 6373·87 Å U. He describes the green coronal radiation as being very feeble or absent.

The Recent Transit of Mercury.—Accounts of the observations of the transit of Mercury in November last are published by numerous observers in several journals. In the Monthly Notices of the Royal Astronomical Society (vol. lxxv., No. 1, November) papers are communicated by the Royal Astronomers of Greenwich and Edinburgh, Mr. R. Jonckheere, Prof. Fowler, and Dr. J. L. E. Dreyer. The different phases seemed to have been well observed at Greenwich, and the Astronomer Royal states that "none of the observers saw the 'black drop,' a halo round Mercury or a bright spot on the planet. The phenomenon appeared just as might have been expected from geometrical considerations." This communication is accompanied by a plate illustrating seven positions of the planet, taken with the photoheliograph just about the times near the beginning of the transit. M. Jonckheere discusses the 368 measures of the diameter of the planet as made at the Royal Observatory, Greenwich, by several observers during the transit. At the Royal Observatory, Edinburgh, no distinctive marking on the planet's disc could be detected nor any halo, and the second internal contact was noted as "quite clean," no ligament of any kind being visible.

Prof. Fowler's observations corroborate the above. An additional observation by him to determine by spectroscopic means whether there was any strengthening of the telluric lines near the limb of the planet led him to conclude that no effect of the kind was seen. Dr. Dreyer's observations at the Armagh Observatory show that while he observed no halo round the planet, he noted the black drop at egress and a bright point or dot on Mercury's disc. In the *Comptes rendus* for November 23 (vol. clix., No. 21) MM. Gonnessiat and Chrétien present two notes on the transit.

ATMOSPHERIC POLLUTION.

AT the International Conference on Smoke Abatement held in London in March, 1912, a committee representative of the Smoke Abatement Societies and of the more progressive municipalities of the United Kingdom was appointed, to promote the systematic and scientific study of atmospheric pollution, in the urban and industrial districts of this country. Dr. W. N. Shaw, director of the Meteorological Office, was elected chairman of this committee. Numerous meetings were held in London during 1912 and 1913, in order to select a standard method and type of apparatus for collecting the impurities, and also to make preliminary arrangements with the various local authorities who had consented to take part in the investigation. The actual observations were commenced in twenty-two different cities and towns in March of the present year, using the method and standard form of soot- and dust-gauge recommended by the committee.

The principle of the method used is that of collecting the soot and other impurities that fall by their own weight, or are carried down by the rainfall in one month, in a large funnel of enamelled iron, with a catchment area of four square feet. These soot and dust gauges are placed in some central position of the town or district on the ground-level, in open spaces free from wind eddies and from abnormal soot and dust. The collected water and deposit are removed once a month, for measurement and examination by the official city chemist, and the following constituents of the rainfall and solid deposit are recorded:—Volume of water collected, total solids, total soluble matter, total insoluble matter, tarry matters, non-tarry carbonaceous matter, sulphates, chlorides, ammonia and lime. The relationship between the amount of tarry matter and the total carbonaceous matter enables one to judge how far the domestic chimney is responsible for the soot-fall in each locality. Factory furnaces and factory chimneys produce under normal conditions little tarry vapour, for the temperature of the furnaces is sufficiently high to ignite and burn these vapours before they escape into the atmosphere. The greater portion of the tar in town and city smoke comes, therefore, from the coal used for domestic heating and cooking purposes.

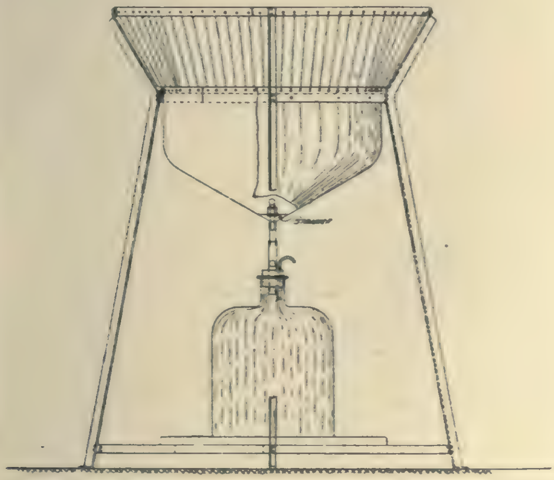

FIG. 1.—Soot Gauge. Standard form.

The standard gauge is shown in Figs. 1 and 2. It consists of a circular open-topped vessel of enamelled iron, supported in a heavy galvanised iron frame, and is provided, as shown, with bottles for holding the month's fall of soot- and dust-laden rain-water. On the first or last day of each month the soot and other solid matter deposited on the interior of the vessel is rinsed down with some of the collected water, and a new set of bottles are placed in position to receive the new month's rainfall.

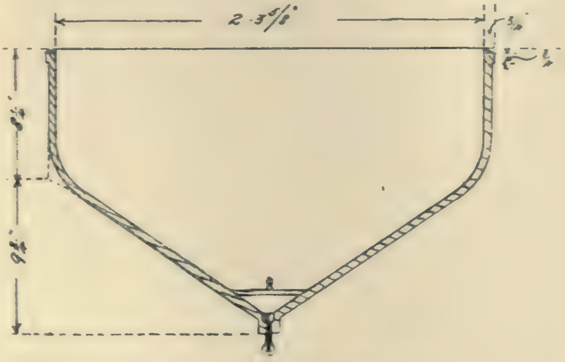

FIG. 2.—Section of Standard Soot Gauge.

The health authorities of the following towns and cities are joining in the observations:—Aberdeen, Ayr, Birmingham, Coatbridge, Exeter, Glasgow, Greenock, Hull, Liverpool, Leith, London (County Council), London (City Corporation), London (Meteorological Office), Malvern, Manchester, Newcastle-on-Tyne, Oldham, Paisley, Plymouth, Sheffield, Stirling, Wishaw, and York. In many cases two or three gauges will be installed at different centres, but at present London is the only city from which returns have been published where more than one gauge is in use.

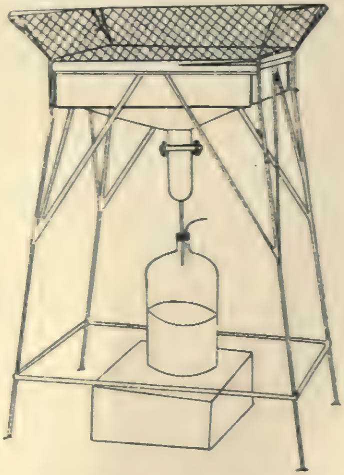

FIG. 3.—Soot Gauge used for *Lancet* observations.

The committee, which is now receiving and coordinating the results, has just published the figures obtained in thirteen of the above observation centres in April and May of this year. Although these are incomplete, owing to the absence of results from Manchester, Glasgow, Sheffield, Leeds, Newcastle, and other important manufacturing towns, the figures are sufficiently interesting and important to be reproduced here.

TABLE I.—*Summary of Reports per Month ending April* 30, 1914.

Place	Rainfall in millimetres	Metric tons of deposit per sq. kilometre in month of April					
		Insoluble matter			Soluble matter		
		Tar	Carbonaceous other than tar	Ash	Loss on ignition	Ash	Total solids
England—							
Exeter	32·30	0·04	2·05	4·71	0·97	1·61	9·38
Kingston-on-Hull..	10·25	0·08	2·71	4·76	0·94	2·50	10·99
Liverpool	22·23	0·36	2·18	8·01	2·40	3·02	15·97
London—Embankment Gardens (Central) ...	15·61	0·27	5·38	6·31	0·72	3·03	15·71
Golden Lane (East)	19·27	0·03	1·41	2·24	1·15	2·24	7·07
Meteorological Office (West)..	18·70	0·05	2·42	5·63	1·87	2·61	12·59
Malvern ...	32·19	0·00	0·14	0·21	0·39	1·03	1·77
Newcastle-on-Tyne	15·31	0·17	4·05	10·55	0·98	2·17	17·92
York	13·23	0·11	2·17	3·26	0·96	1·69	8·19
Scotland—							
Greenock	94·70	0·03	1·32	3·13	1·71	3·45	9·64
Leith	24·63	0·08	1·01	3·27	1·53	1·02	6·91
Paisley	75 80	0·08	4·17	6·46	2·42	2·73	15 87

TABLE II.—*Summary of Reports for Month ending May* 31, 1914.

Place	Rainfall in millimetres	Metric tons of deposit per sq. kilometre in month of May					
		Insoluble matter			Soluble matter		
		Tar	Carbonaceous other than tar	Ash	Loss on ignition	Ash	Total solids
England—							
Birmingham... ...	35·60	0·18	4·79	15·92	1·71	7·26	29·86
Exeter	41·80	0·05	2·37	3·56	0·79	1·97	8·74
Kingston-on-Hull..	44·61	0·16	3·86	4·51	2·50	3·39	14·42
Liverpool	56·14	0·16	4·11	8·96	2·47	4·94	20·64
London—Embankment Gardens (Central) ...	21·47	0·61	7·18	6·51	0·86	2·62	17·78
Golden Lane (East)	46·74	0·08	3·37	5·72	1·68	3·74	14·59
Meteorological Office (West)..	35·20	0·05	1·57	2·96	0·00	2·11	6·69
Malvern	34·76	0·02	0·27	0·41	0·69	1·25	2·64
Newcastle-on-Tyne	29·19	0·12	3·18	5·56	0·93	1·93	11·72
York	33·73	0·02	0·85	3·15	1·08	1·35	6·45
Scotland—							
Greenock	52·30	0·04	1·93	4·51	1·39	2·25	10·12
Leith	46·10	0·49	0·79	2·92	1·19	1·19	6·58
Paisley	49·68	0·15	4·53	6·66	1·20	1·99	14·53

Adding together the results recorded in Tables I. and II., and arranging the towns in order of the magnitude of their fall of soot and dust in the two months, we obtain the figures given in Table III.

TABLE III.—*The Soot and Dust Fall of various English and Scotch Towns in April and May.*

Name of town or city	Metric tons per sq. km. in two months			
	Total solids		Tar, soot, and grit	
Liverpool	36·51		23·78	
Paisley	30·42		22·05	
Newcastle	29·64		23·63	
Kingston-on-Hull...	25·41		16·08	
London (Central)...	33·5	Average 24·8	26·26	Average 17·3
,, (East) ...	21·6		12·85	
,. (West) ...	19·2		12·69	
Greenock	19·76		10·96	
Exeter	18·12		12·78	
York	14·64		9·56	
Leith	12 23		8·56	
Malvern	4·45		1·05	
Birmingham (one month only)	29·86		20·89	

The difference between the figures in the second and third columns of this table gives the soluble solid matter brought down by the rain.

It is surprising to find that the atmosphere of Birmingham and of many northern towns is considerably dirtier than that of London, which in this respect has a reputation it does not deserve. Malvern is seen to be far the cleanest town in the list, since the total soot and dust-fall in April and May, 1914, only amounted to 4·45 tons per sq. km., or to about one-fifth that of London, and one-eighth that of Liverpool during the same two months.

Figs. 1 and 2 are sectional elevations of the standard gauge, while Fig. 3 shows the gauge used for the observations of London's soot-fall, carried out in 1910–11 by the *Lancet* and the Coal Smoke Abatement Society.

THE NATURAL HISTORY OF AN AMERICAN DESERT BASIN.[1]

THE staff of the Botanical Research Department of the Carnegie Institution of Washington has made many valuable contributions to natural science, particularly in the study of desert vegetation, at the Desert Laboratory, Tucson, Arizona. The recently issued monograph on the Salton Sea is in many respects unique, for it deals with a remarkable series of phenomena, opportunities for the study of which are but rarely presented. That the Desert Laboratory workers have taken full advantage of this opportunity is evident from the perusal of this volume, interesting to the geologist, the geographer, and, above all, to students of plant ecology. The chief interest of this fine piece of co-operative research centres, as the editor and chief contributor point out, around the fate of organisms overwhelmed by floods, in the physical changes which follow emersion, and in the biological mechanism of reoccupation of sterilised areas as they emerge from the water—episodes which must have been repeated many times in the history of the earth's surface. The report gives the results obtained by the investigation from various points of view of the phenomena presented by a desert basin which has been the scene of alternate submergence and desiccation.

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[1] "The Salton Sea: a Study of the Geography, the Geology, the Floristics, and the Ecology of a Desert Basin." By D. T. MacDougal and Collaborators. Pp. x+182+32 plates. Publication No. 193. (Washington: Carnegie Institution, 1914.)

The Cahuilla basin, lying to the west of the lower (southern) portion of the main delta of the Colorado River, was in Tertiary times cut off from the sea and so became a brackish inland lake (Lake Cahuilla). The lake bed, now called the Salton Sink, has its upper margin about 20 ft. above mean tide-level, while its lowest point, now beneath the water of the present lake (Salton Sea), is 280 ft. below this level. On either hand of the Sink, which is oblong in outline (about eighty miles long and thirty miles in greatest width), there rise arid and sun-scorched low mountains, chiefly of granite, the slopes and waterless cañons of which bear a scanty vegetation. The Sink is practically a level plain, with no irregularities of surface to vary the effects of sun and wind, with a uniform temperature and uniform deficiency of atmospheric humidity and precipitation, the latter being on the average 2·7 in. a year. The ancient lake which originally filled the Sink had almost or entirely disappeared by evaporation, leaving a series of beach-lines, but during 1905 and 1906 the cutting of canals and the resulting escape from control of the Colorado River water resulted in a partial re-flooding of the basin and the formation of the Salton Sea, threatening the restoration of the former lake conditions and necessitating the removal of the Southern Pacific Railway track for sixty-seven miles to a higher bed. In 1907, however, the railway engineers stopped the deluge by re-diverting the Colorado water to the Gulf of California, and the gradual disappearance by evaporation of the Sea then began and is still in progress. Since 1907 the average annual rate of lowering of level by evaporation has been about 5 ft., while the concentration of the water has risen until the proportion of total solids is now more than 1 per cent. Succeeding the chapters on the geology, geography, climate, and water analyses, the remainder of the report (pp. 48–182) is devoted to the biological results obtained. Prof. G. J. Peirce gives an interesting account of the behaviour of the micro-organisms found in the Salton Sea, and in the strong brines from which salt is crystallising out naturally or in the artificial salt-pans on the shores of the lake. It has long been known that various organisms live under what are commonly regarded as fatal conditions—*e.g.* the mould-fungi which thrive on solutions of strychnine, formalin, carbolic acid, etc., the insects in oil-wells and asphaltum, those in hot springs and in snow, and so on—but in these cases the conditions are fairly stable, and it is harder to understand how organisms like the brine-shrimps (Artemia) and various protozoa, flagellates, and algæ found in the Salton Sea and other strong brines can exist under conditions ranging from rain-diluted sea-water to concentrated brine from which common salt crystallises. The lower organisms upon which the brine-shrimps and protozoa feed are mainly Pyramimonas, Dunaliella, Carteria, and various bacteria. The latter are entirely different from the bacteria which cause putrefaction in waters of the usual concentrations, and which are killed by the Salton brine—a concentrated solution of sodium chloride and of magnesium salts. The most conspicuous are a chromogenic form which gives a red colour to the salt in the salt-pans and to fish pickled in the salt, and a cellulose-destroying form which attacks stems and other plant-remains submerged in the lake.

A rocky island in the Salton Sea, Southern California, formerly submerged but now exposed by the recession of the lake owing to continued evaporation. The rock shows colonisation by a desert shrub, *Pluchea sericea* (Compositæ).

The present flora of the Salton Sink includes 179 species of seed-plants, the great majority being salt-plants (halophytes) and plants adapted for life under dry conditions (xerophytes); the former are mainly members of the Chenopodiaceæ. Apart from the salt-mud plants, the vegetation of the Sink is a part of the general flora of the Colorado desert, differentiated mainly by the great preponderance of species of the orache genus (Atriplex) in its composition, and it is of a remarkably uniform character. Three main communities or associations can be distinguished, according to the nature of the soils—coarse-grained, detrital slopes, clays, and mound-forming drifted materials.

The longest report (pp. 115–72) is that by Dr. MacDougal, dealing with the movements of vegetation in the area. The phenomena observed on the emersed lands of the Sink are widely different from those hitherto investigated in the case of Krakatau, the cooling lavas of the Hawaiian Islands, newly-made land about the mouths of rivers, etc. The chief features in the re-vegetation of the beaches successively exposed each year by the recession of the water are described in detail, but the following were the chief points to be taken into account in noting the progress of re-vegetation. As the salt content of the water increased by about 18 per cent. in each succeeding year, each emersed strand would be saturated with a soil solution of the concentration and composition prevalent in the period preceding emergence, and the desiccation of the emersed strands would proceed at a rate determined by the character of the soil (*e.g.* its capillary raising power), and by the composition of the infiltrated lake water. The re-vegetation of the strand bared in 1907 was chiefly due to the rising water picking up seeds lying on the surface and leaving them on the wet flats, but since that year the plants invading the new strands were carried there as seeds by the wind, by flotation, or by birds, only those plants surviving as could withstand the rapid warming of the shallow water on the mud flats, which increased its toxicity for seeds and seedlings, and the rapid desiccation of the surface soil, which increased the difficulties of the rooting and establishment of the plants.

The report is illustrated by thirty-two beautiful collotype plates, and interesting as are the results already obtained, the continued investigation of the phenomena presented by the re-vegetation of this sterilised desert basin area under difficulties which will become increasingly great as evaporation proceeds will doubtless yield even more valuable results in the future. F. C.

FINISHING TEMPERATURES OF RAIL STEEL.

REPRINT No. 38 of the Technologic Papers of the Bureau of Standards, by Messrs. Burgess, Crowe, Rawdon, and Waltenberg, deals with observations on the finishing temperatures and properties of steel rails. The principal objects of the research were to "determine from measurements taken in representative rail mills, the present American practice regarding the temperatures at which rails are rolled, to demonstrate the ease and accuracy with which such temperatures may be measured, and to find out what the 'shrinkage clause' in rail specifications really means."

The authors have found that ingots for rails are rolled at temperatures ranging from 1075° to 1150° C., and that the variation from one ingot to another in a series of 20 to 40 is only 10° to 20° C. The rails are finished at temperatures which may vary between 880° and 1050° C., but which usually come within 50° C. of 935° C. With uniform mill practice the rails of 100-lb. section will be finished at some 10° to 20° C. hotter than 90-lb. rails, and about 50° C. hotter than 75-lb. rails. The melting or freezing range of such steels extends from about 1470° to 1530° C., *i.e.* to nearly the melting point of iron. The critical Ac 1 point was found to occur within 7° C. of 732° C. for the ten samples of Bessemer and open-hearth steels examined. On cooling the corresponding Ar 1 point occurs between 680° and 650° C.

In all cases, therefore, the temperature at which the rolling of the rails ceases was at least 200° C. above the critical point, and there is no doubt that the rolling temperatures could with advantage have been carried much lower than they actually were. A rail of 100-lb. section, cooling freely in the air from 1070° C., reaches the recalescence point (Ar 1) in about 8½ minutes; and the maximum difference in temperature between the centre and the outside of the head is about 85° C. at 1000° C., becoming 0° at the recalescence point. A comparison of the "shrinkage clause" specification with the expansion of rail steel shows that this clause permits the finishing of rails at 1120° C., which is 450° C. above the critical range of such steel and is *above* the temperature at which many rail ingots are rolled in practice. In its present form, therefore, the clause has absolutely no significance.

FOREST ENTOMOLOGY.

A VALUABLE Bulletin (Entom., No. 7) of the Canadian Department of Agriculture on forest insect conditions in British Columbia, has been lately issued by Mr. J. M. Swaine. The author deals mostly with the Scolytidæ injurious to the more important species of pine, spruce, and fir; he gives interesting summaries of the life-histories, illustrated by excellent figures of the beetles, their larvæ, and their characteristic brood-galleries in the bark of the trees.

The "large larch sawfly" (*Nematus erichsonii*)—notorious for its ravages in the Cumbrian Lake district—continues to occupy the attention of zoologists in the University of Manchester. Mr. R. A. Wardle contributes to the last number of the *Journal of Economic Biology* (vol. ix., No. 3) some notes on the life-histories of two of its parasites hitherto unrecorded; these are *Zenillia pexops*, a Tachinid dipteron, and *Hypamblys albopictus*, an Ichneumon-fly. The first-stage larva of the latter, with its relatively big head, elongate tail-process—variously interpreted as a blood-gill or a pro-leg—and paired, limb-like outgrowths on the body-segments, is remarkable. Several of these young grubs may occur in one sawfly caterpillar, but apparently only one of them is able to pass through the subsequent larval stages and become in due course a pupa. There appears to be rather severe competition among the various parasites of the Nematus, so that there may be danger of their weakening one another in the process of reducing the numbers of their host.

The pine weevil (*Hylobius abietis*) is one of the most abundant of our native woodland insects. Mr. J. W. Munro has lately published (Proc. R. Phys. Soc. Edinb., vol. xix., No. 6) the fullest account yet available of the reproductive organs in both sexes.

AUSTRALIAN HANDBOOKS FOR THE BRITISH ASSOCIATION.[1]

IN connection with the recent meeting of the British Association in Australia, official handbooks were issued for the Commonwealth and for all the States—Western Australia, South Australia, Victoria, New South Wales, Queensland, and Tasmania. Copies of all were distributed among the visiting party, in most instances before the travellers had left home, so that it was competent for the recipients to inform themselves thoroughly on Australian topics before reaching the country. Members joining locally in Australia received the Commonwealth volume and that relating to their own State. The volumes are not uniform in style, though they were all prepared on an approximately uniform plan, specially for the occasion, with the exception of the Queensland volume, which was that originally issued in 1909, by authority of the Government, under the title of "Our First Half-Century," in commemoration of the jubilee of the State.

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[1] The Commonwealth of Australia. Federal Handbook prepared in connection with the 84th meeting of the British Association for the Advancement of Science, held in Australia, August, 1914. Edited by G. H. Knibbs. Pp. xvi+598. (Melbourne: Mullett.)

Handbook and Guide to Western Australia. Prepared for the Members of the Advance Party of the British Association for the Advancement of Science. Pp. vi+118. (Perth: F. W. Simpson, 1914.)

Handbook of South Australia. British Association for the Advancement of Science. Australian Meeting, 1914. Adelaide. Joint Editors: D. J. Gordon and V. H. Ryan. Pp. 328. (Adelaide: R. E. E. Rogers, 1914.)

British Association for the Advancement of Science. Australian Meeting, 1914. Handbook to Victoria. Prepared under the direction of the Victorian Executive Committee, by A. M. Laughton and Dr. T. S. Hall. Pp. xvi+382. (Melbourne: A. J. Mullett, 1914.)

British Association for the Advancement of Science, 1914. Handbook for New South Wales. Pp. xiv+621. (Sydney: E. Lee and Co.)

Our First Half-Century. A Review of Queensland Progress. By Authority of the Government of Queensland. Pp. xxviii+258. (Brisbane: A. J. Cumming, 1909.)

British Association for the Advancement of Science. Tasmanian Handbook. Pp. iv+348. (Hobart: J. Vail, 1914.)

The volumes form a fine monument to the scientific achievements of Australian workers, for they contain chapters by acknowledged experts in every department of science—natural, economic, social, and political. Thus the Commonwealth volume, edited by Mr. G. H. Knibbs, the Commonwealth statistician, and published at the charge of the Federal Government, contains chapters on the history of Australia, by Prof. Ernest Scott, of Melbourne; the aborigines, by Prof. Baldwin Spencer; physical and general geography, by Mr. Griffith Taylor; climate, by Mr. H. A. Hunt; vegetation, by Mr. J. H. Maiden; animal life, by Prof. W. A. Haswell; geology, by Prof. Edgeworth David, Prof. E. W. Skeats, and Messrs. T. S. Hall, W. S. Dun, and F. Chapman; astronomy and geodesy, by Mr. P. Baracchi; pastoral and agricultural development, by Mr. G. A. Sinclair; mining fields, by Mr. E. F. Pittman; manufactures, etc., by Mr. Gerald Lightfoot; education, by Prof. F. Anderson; political systems, by Prof. Harrison Moore; and miscellaneous notes, by the editor. This is in itself a very notable list, and while some of the names in it reappear among those of the contributors to the States volumes, we find also in these the names of other well-known workers in special fields, too many to detail here.

It is the purpose of the Commonwealth volume to provide a general scientific survey of Australia, while the States volumes give details each for each. While absolutely perfect co-ordination between the various volumes was scarcely to be expected, the many writers have clearly received and acted upon very precise editorial instructions as to their different fields, and duplication has been avoided as far as possible. Thus, even if the visit of the association had effected no other good, it has brought into existence a remarkable compendium of present knowledge of the continent of Australia and its resources, and a record of progress in human endeavour to make use of those resources, such as exists probably for no other country which is at a similar stage of development. These volumes, therefore, apart from their intrinsic interest and value at the moment, will become a valuable historical record. Frequently throughout them all writers are found to look forward to fields of future work, whether in the direction of pure scientific research or of economic development in which science will play a leading part.

In most of the volumes there are many excellent photographic reproductions, though the New South Wales book is less satisfactory than the rest in this respect. Particular mention may be made of a coloured plate in the Western Australia volume representing some of the wild flowers for which the State is famous. When photographic illustration is so successfully carried out, it is the more notable that the draughtsmanship and reproduction of maps is generally not so, and the valuable material which is available in the departments of geology, meteorology, and others suffers to some extent, though not always, in its representation by this means.

These handbooks were supplemented by booklets dealing with many of the excursions undertaken by members from different centres, so that the scientific interests of the visitors were provided for at almost every step, even if the guidance and verbal demonstrations given by their leaders on the spot had been less efficient than it was. The subject-matter of each State handbook is arranged under headings broadly similar to those of the Commonwealth book detailed above, with the exception of the Queensland volume, which, having been prepared, as has been seen, for a different purpose originally, deals more exclusively with historical, economic, and social topics than the others. From the point of view of the natural sciences this is unfortunate, but with such a book already in existence it was perhaps not to be expected that another should have been compiled.

It may be well to make clear that the British Association is not concerned in the issue of these books, which were compiled and issued by the Australian authorities; it is not stated whether they will be made accessible to the public.

CHEMISTRY AT THE BRITISH ASSOCIATION.

MEETINGS of the Chemistry Section were held only in Melbourne and Sydney, but in each of these cities they extended over three days. There were two joint discussions with other sections, and a number of locally contributed papers showed that in both Victoria and New South Wales a considerable amount of chemical research is being carried out, some happily on lines of special interest and value to Australia. It is to be regretted that such local features as the natural products of the characteristic Australian indigenous flora and the important problems connected with soil should not earlier have attracted local chemists, but as two sectional committees of the association are now engaged in examining the natural plant products we may hope that much will be recorded before the ever-increasing destruction of native trees and plants precludes any attempts at completeness.

MELBOURNE.

After the president's address Prof. Masson described an ingenious rearrangement of Mendeléeff's periodic table, by means of which many of the existing difficulties are removed. Instead of writing the elements in their eight groups in a two-dimensional figure throughout, Prof. Masson uses a mixture of two and three dimensions. Suppose the elements (rare earths excepted) be written in the order of their atomic weights on the inside of the covers of a book in horizontal lines, and the rare elements in their appropriate place along an uncut leaf, a fair picture of the arrangement is given. The rare earths follow each other along a horizontal series with little difference between any two members, but the end members of the series approximate to the ordinary elements found on the extreme right-hand side of the left-hand cover and the left side of the right-hand cover in the same horizontal line as the rare earths. Prof. Masson places hydrogen with the halogens, a position that is at least disputable, though by doing so the inactive gases at once form a complete series. Several properties of hydrogen and the hydrides are held to justify this position and the atomic weight of fluorine is almost the mean between those of hydrogen and chlorine.

Mr. F. H. Campbell described a method for the determination of vapour pressures the principle of which is that a liquid saturated with a suitable gas (usually hydrogen) is allowed to evaporate into an enclosed space filled with the same gas at the same temperature and pressure. After the volume has been restored to its original value the increase in pressure is recorded on an open manometer.

A new method for determining the specific heat of liquids was described by Mr. E. G. Hartung. It consists in measuring the lowering of temperature of a known amount of the particular liquid on the introduction of a definite weight of dry ice contained in a thin glass bulb, and the method claims attention on account of its simplicity, rapidity, and accuracy, except in the case of viscous liquids like glycerine. The formation of nitric and nitrous acids in the rainfall near Melbourne has been correlated with the weather conditions by Mr. G. V. Anderson, and reveals the fact that the nitrous acid attains a maximum in winter, and a minimum in summer. It further varies with the type of weather, the total oxidised nitrogen attaining a maximum with monsoonal and a minimum with Antarctic conditions.

A joint discussion with the Physics Section on the structure of atoms and molecules has been referred to elsewhere in NATURE. It will suffice here to say that there appears to be a gulf between the views of the physicist and chemist, and little attempt made to bridge it. The former concentrates attention on the internal atomic structure, at present of only secondary importance to the chemist, while on the chemically all-important matter why atoms combine in definite ways to form molecules he has little or nothing to say.

The Melbourne programme was completed with papers by Prof. G. T. Morgan on residual affinity and co-ordination, and by Dr. A. Holt on a comparison of the phenomenon of the occlusion of hydrogen by charcoal and by palladium.

SYDNEY.

A joint discussion with the Agricultural Section on metabolism occupied one day, and was a most successful feature of the sectional programme. It was opened by Prof. H. E. Armstrong, and among the various speakers may be mentioned Mr. A. D. Hall, Mr. Darnell-Smith, Profs. B. Moore, Waller, and J. B. Wood. The discussion covered a considerable field, and for convenience may be divided into three parts. The earlier part was devoted to what may be called the formaldehyde problem and enzyme action. It cannot be said that any very definite conclusion was reached, but many interesting views were put forward, so that though the photo-synthetic processes associated with assimilation may still be said to demand further attention, great advances have been made along this line of research. Enzyme action is a fruitful field for speculation. It may be true, as suggested in the discussion, that for the metabolic synthesis of protein and fat from carbohydrates a linkage and co-ordination of an endothermic with an exothermic reaction is necessary, and that for such synthesis a colloidal regulating mechanism must be furnished by an adsorption of enzymes into the cell protoplasm, but enormous difficulties are presented to the experimental proof of such views, and when we are told that an enzyme being a colloid has its action determined by its previous history, and hence that two portions of the colloid may act differently, confusion and difficulty of proof becomes greater. This part of the discussion was full of interest, for it showed the keen attention that is being paid to those all-important subjects.

Production of fat and skin temperatures was next considered, and the conclusion was reached that though many factors come into play, fat production is associated with low skin temperatures. As the air temperature rises the skin temperature may be higher than that of the internal organs, and hence skin temperatures must not be carelessly employed as an indication that an animal is a good or bad doer, for fat production and internal temperature must also be related.

The discussion was concluded by papers dealing with cyanogenetic plants and distribution of nitrogen in seeds by Dr. J. M. Petrie. It appears that in New South Wales more than a thousand species of plants have been examined for hydrocyanic acids and cyanogenetic glucosides, sixty of them giving positive results, and of these forty-four were native to the State, and represented seventeen natural orders. Some plants which are cyanophoric in Europe do not appear to be so in Australia, whilst in others, the Australian grown plant retains its glucoside to maturity instead of losing it when half-grown. A series of specialised papers, six of which were contributed locally, were read on another day, but it is only possible here to enumerate their authors and titles. Prof. G. T. Morgan, "Non-aromatic Diazonium Salts"; Prof. Robinson, "Researches on the Synthesis of *iso*Quinoline Alkaloids"; Mrs. G. M. Robinson, "Condensation of Cotarnine and Hydrastinine with Aromatic Aldehydes"; Dr. H. McCombie, "Influence of Substituents on the Velocity of Saponification of Phenyl Benzoate"; Dr. A. Holt, "The Colouring Matters of Certain Marine Organisms"; Prof. Fawsitt, "The Corrosion of Iron and Steel by Artesian Waters in New South Wales"; Dr. G. Harker, "The Use of Waste Gases of Combustion for Fire Extinction and Fumigating Purposes"; Mr. S. Radcliff, "The Extraction of Radium from Australian Ores"; Mr. G. J. Burrows, "The Inversion of Cane Sugar by Acids in Water-Alcohol Mixtures."

An experimental lecture by Prof. H. B. Dixon on gaseous explosions and a beautiful demonstration of optical properties of crystals and liquid crystals by Prof. Pope completed the programme. Both were attended by large and appreciative audiences. In conclusion it may be said that the work of the section was in every way successful, and was almost double in amount that at an ordinary meeting in Great Britain. The audiences, too, were good, and though the Australians are so distant from their brother chemists in Europe they exhibit an interest and enthusiasm not always seen in meetings of the section at home.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—The University Court has framed an Ordinance establishing the degree of B.Sc. in applied chemistry. The curriculum extends over four years, and includes nine full courses of study, of which five at least must be taken in the University or in the Royal Technical College affiliated thereto. After the usual preliminary examination, courses in mathematics, natural philosophy, and chemistry are prescribed, followed by a first science examination. Thereafter the student may pursue courses of study in advanced chemistry, inorganic, physical, and organic; technical chemistry and chemical engineering; engineering drawing; practical physics; and one of certain special branches, such as fuels, dyeing, oils, sugar, biochemistry, and technicological mycology (fermentation). Or, on the metallurgical side, he may take courses in advanced chemistry (inorganic), geology, and mineralogy; engineering and drawing; metallurgy, including fuels; electrical engineering; and one of certain special branches, such as precious metals, non-ferrous metals, iron and steel, and alloys, and their treatment for engineering purposes. These courses are followed by a final science examination in which special distinction may be obtained in particular subjects. The degree is to be of an honours standard, and will qualify for subsequent admission to the doctorate, on the production of original work of distinction. The Ordinance will be duly submitted for the approval of his Majesty in Council. The joint resources of the chemical departments of the University and the Technical College will make it possible to provide for a complete scheme of instruction and training in preparation for the degree, which will be a valuable qualification for the chemical industries. The step taken by the University is particularly opportune in present circumstances.

Dr. T. H. Havelock, F.R.S., has been appointed to the recently created chair of applied mathematics and mathematical physics in Armstrong College, Newcastle-on-Tyne, in the University of Durham.

Sir Robert G. C. Mowbray, Bart., Prime Warden of the Worshipful Company of Goldsmiths, will distribute the prizes at the Sir John Cass Technical Institute on the evening of Wednesday, January 13, 1915, and on the same occasion will open the new metallurgy laboratory for the mechanical testing of metals and alloys, presented to the institute by the Goldsmiths' Company.

The annual meeting of the Mathematical Association will be held on January 9, 1915, at 2.30 p.m., at the London Day Training College, Southampton Row, London, W.C. The president, Sir George Greenhill, will give an address on mathematics in artillery science, and Dr. W. P. Milne will speak on the teaching of modern analysis, Mr. A. Lodge on circles of curvature, and Mr. R. C. Fawdry on practical work in connection with mathematics.

The Cambridge University Calendar for the year 1914–15 has now been published. The last issue of the "Calendar" had reached unwieldy dimensions; it contained 1547 pages. The size of the present issue is 1064 pages, and this reduction has been effected in two ways, namely, by transferring some Tripos Lists to "The Historical Register," and retaining only the lists for the preceding ten years, and by treating "The Student's Handbook" as a companion volume and omitting from the calendar the information about examinations which the former book already contains.

The annual meeting of the Geographical Association is to be held on January 7, 1915, in the Jehangier Hall, University of London, South Kensington. At the morning session, which will begin at 10.30, a lecture will be delivered by Mr. P. M. Roxby on some aspects of the geography of China, and a discussion on the value of surveying in teaching geography will be opened by Messrs. Ernest Young and J. A. White. In the afternoon at 2.30 Mr. Hilaire Belloc will give the presidential address, and afterwards a discussion on the place of map tests in examinations will be opened by Dr. J. F. Unstead and the Rev. W. J. Barton.

In the recently published report of the United States Bureau of Education for the year ending June 30, 1913, some interesting statistics are provided relating to the 596 American institutions of higher education from which the bureau receives reports. The total sum received in gifts and bequests, excluding grants by the United States, different States, and municipalities, reported for the year was 4,930,392*l.*, showing a decrease of 26,226*l.* Of this amount 895,316*l.* was for increase of plant, 825,980*l.* for current expenses, and 3,209,096*l.* for endowment. Forty-five institutions reported gifts above 20,000*l.* Among the institutions most generously treated, the following may be mentioned: Harvard University, 419,090*l.*; Columbia University 284,361*l.*; Yale University, 283,787*l.*; University of Chicago, 261,586*l.*; University of California, 249,192*l.*; Trinity College, N.C., 240,639*l.*; and Massachusetts Institute of Technology, 214,322*l.* The income of the 596 institutions was during the year from State and municipal grants, 3,809,965*l.*; from invested funds, 3,313,962*l.*; and from fees for tuition and other educational services, 4,183,835*l.*

The council of the London (Royal Free Hospital) School of Medicine for Women has made a public appeal for the sum of 25,000*l.* to pay for additional buildings urgently needed, and their equipment. The school was the first women's medical school in the kingdom, and since it was opened in 1874 it has been continuously successful. Of the thousand or so women now on the medical register more than six hundred are former students of the school. For its work in the past and to secure provision of sufficient numbers of medical women in the future, more lecture-rooms are essential, as well as additional laboratory accommodation and new research rooms. A site has been secured and plans have been prepared and approved, but funds are needed to pay for the buildings shortly to be commenced. It is hoped that in spite of the many demands made upon national generosity at the present time, there are yet sufficient people interested in the work and medical education of women to provide the 25,000*l.* required. Donations or promises should be sent to the London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, W.C., addressed to the hon. treasurer, Mr. M. J. Henderson.

Alderman Sir James Henderson, of Belfast, occupied the position of chairman of the Library and Technical Instruction Committee, Belfast, from the inception of the committee until the date of his death in May of the present year, and to his memory a portrait in oils was unveiled in the Municipal Technical Institute, Belfast, on Wednesday, December 9. Sir James Henderson was identified in a very intimate manner with the remarkable progress which technical instruction has made in the city of Belfast, and the development of the corporation education scheme owed much to his unceasing efforts. The portrait was presented by the principal, staff, and students of the institute. It is to be hung in the library of the institute, where—as was said by the principal of the institute in his explanatory remarks at the ceremony—it will be a reminder not only to the present generation, but also to future generations, of teachers and students of the magnificent work that was done by the first chairman of the Technical Instruction Committee and of the splendid contribution Sir James had made to the great cause of technical instruction in Ireland. The Lord Mayor of Belfast (Councillor Crawford McCullagh), who unveiled the portrait, made reference to the many civic activities of the late chairman of the Technical Instruction Committee, adding that the Municipal Technical Institute would in itself be a lasting monument to the fine public spirit and enthusiasm of him who was depicted in the portrait. At the conclusion of the proceedings a booklet, containing a reproduction of the portrait, and also an address given by the principal at the meeting of the staff and students at which the memorial was decided upon, was distributed to the members of the audience. The portrait, which is an admirable likeness, was painted by Mr. W. G. Mackenzie.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 27.—Dr. A. Russell, vice-president, in the chair.—A. F. **Hallimond**: Note on the conduction of electricity at point contacts. The "characteristic" or volt-ampere curves given by various "point" contacts when the voltage is slowly varied are dealt with. The curves were plotted by means of a form of rocking mirror galvanometer, which projected the characteristic as the path of a spot of light on the screen, the co-ordinates being respectively proportional to the current and voltage. The first part describes the behaviour of a typical contact, zincite-tellurium. The second part describes the results obtained on examining the characteristics for the forty-five contacts possible between ten chosen substances. The results in all cases are similar to those given by zincite-tellurium. No line could be drawn separating "metallic" contacts from those in which one or both conductors were "crystals." In the third part the conclusion is drawn that in a contact yielding the unilateral (high resistance) curve, the resistance lies within the surface of the member standing higher in the series.—T. **Barratt**: Thermal conductivity of badly conducting solids. The thermal conductivities of typical solids of low thermal conductivity have been determined by the method employed by the author for pure metals and alloys. The substances tested include electrical insulators, such as glass, fused silica, and ebonite, various kinds of wood, and some partial conductors of electricity—viz., carbon and graphite. It has been shown that the thermal conductivity k is given by

$$k=\frac{H^2 \coth^2 al}{pqhV^2},$$

or, where "l" is sufficiently great,

$$k=\frac{H^2}{pqhV^2},$$

Where H is the heat given to one end of the specimen, of length l, perimeter p, and cross-sectional area q; V is the difference of temperature of the "hot" end of the specimen and the enclosure; h is the heat lost from 1 sq. cm. of the surface per second when its temperature is 1° C. above that of the enclosure; and

$$a=\sqrt{\frac{hp}{qk}}.$$

In nearly every case the simpler form of the equation could be used. For the first time in the measurement of thermal conductivity a direct comparison of this quantity in the case of a non-metal has been made with that of a metal—viz., bismuth—the conductivity of which is of the same order of magnitude as those of some of the non-metals. The results agree well with those obtained by Prof. Lees's "disc" method in cases where direct comparison is available.

Geological Society, December 2.—Dr. A. Smith Woodward, president, in the chair.—Prof. T. McKenny **Hughes**: The age and character of the Shippea Hill man. A description of the skeleton, and of the circumstances in which it was found, is given. The mode of formation of the deposit in which the remains occurred is discussed. The Pleistocene deposits of the Fenland were, it is considered, laid down in a depressed river-basin behind a breached seaward barrier. Gravels of the age of *Elephas antiquus* and *Rhinoceras merckii*, as well as gravels of the age of *E. primigenius* and *R. tichorhinus*, occur within the Fenland; but they are distinguishable from the gravels which are sometimes associated with the peat and clay, and pass under them. The fauna also of the peat- and clay-deposits is quite different. In an embayed part of the Fen, close behind the island known as Shippea Hill, the skeleton was found in the peat, a few inches above the clay which is considered to be the equivalent of this Littleport Cockle Bed. When first dug out the skull was in fragments, and the calotte, with its prominent brow-ridges, suggested to many a greater affinity to the Neanderthal type, and a greater antiquity than appeared probable when the rest of the cranium was added to it.—C. **Dawson** and Dr. A. Smith **Woodward**: A bone implement from Piltdown (Sussex). Excavations have been continued in the Piltdown gravel round the edge of the area previously explored. Rolled fragments of highly mineralised teeth of Rhinoceros and Mastodon were again found, but no human remains were met with. The most important discovery was a large bone implement now described. This specimen was found in dark vegetable soil beneath the hedge which bounds the gravel-pit, not far from the spoil-heap whence the right parietal bone of the Piltdown skull was obtained two years ago. On being washed away the soil left no stain on the bone, which was covered with firmly adherent yellow clay, closely similar to that of the flint-bearing layer at the bottom of the gravel. The bone itself is highly mineralised, and agrees exactly in appearance with some small fragments of bone discovered actually in place in the clay just mentioned. There can be no doubt that the implement was found by workmen digging gravel from the adjacent hole, and thrown away with other useless débris. It is a stout and nearly straight narrow flake of bone, 41 cm. long, and varying from 9 to 10 cm. in width, with the thicker end artificially pointed, the thinner end artificially rounded. It appears to be a longitudinal strip flaked from a limb-bone by a blow at the thicker end, in the same way as flint implements were flaked from their original cores. Direct comparison suggests that it was taken from a Proboscidean femur as large as that of *Elephas meridionalis.* In microscopic structure it agrees with Proboscidean bone. The ends of the implement are shaped by cutting, and bear no marks of grinding or rubbing. Most of the cut facettes are small, and many suggest that they were made by a primitive tool, presumably a flint. The rounded end seems to have been trimmed for comfortable handling. The thick pointed (or, rather, keeled) end shows signs of battering or scratching by use. Just above the pointed end one lateral edge of the bone is marked by a large smooth groove running across from the inner to the outer face of the bone. It seems to have been originally a perforation from which the outer wall has been accidentally broken away. Within it on the inner face is the beginning of a second similar perforation, as if an attempt had been made to repair the damage. The conclusion is that the implement is unique, and no explanation of its specific use is given.

Linnean Society, December 3.—Prof. E. B. Poulton, president, in the chair.—R. C. **McLean**: An ecological journey in South America.—C. **West** and Hisayoshi **Takeda**: *Isoëtes japonica*, A. Br. *I. japonica*, A. Br., which has a fairly wide distribution in Japan, is the largest known species of this genus; according to Makino, a diameter of 8 cm. is attained by the caudex of very large specimens. The tri-lobed caudex consists of two distinct structures, viz., *stem* and *rhizophore*, to which the leaves and roots are respectively attached. But owing to the stunted growth of the plant, all external morphological differentiation between the two organs has been completely lost.

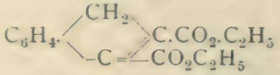
Mathematical Society, December 10.—Sir Joseph Larmor, president, in the chair.—E. H. **Neville**: Simultaneous equations, linear or functional.—Prof. W. **Burnside**: Cyclotomic quinquisection.—Prof. D. **Buchanan**: Oscillations near the isoscles triangle—solution of the three-body problem.—Prof. E. T. **Whittaker**: Larne's differential equation and ellipsoidal harmonics.

CAMBRIDGE.

Philosophical Society, November 23.—Prof. Newall, president, in the chair.—F. A. **Potts**: The colour variations of the fauna associated with crinoids. The commensals of the crinoid *Comanthus annulatum*, which is found in vast numbers on the reefs of Torres Straits, include amongst the Crustacea two species of Alpheids, three Galatheids, a Periciimenes, an Isopod, and an Amphipod. There are also brittle-stars, a polychæt, and many Myzostomids. In most cases the commensals match the host in colour and arrangement of the markings. As the crinoid varies from very light- to dark-coloured types there is also a great variability in the commensals. In the Crustacea there is an alternation of darkly pigmented stripes with non-pigmented areas, and the relative proportions of these vary with the coloration of the host. The phenomenon is best studied in the two species of Synalpheus.—Dr. H. B. **Fantham** and Dr. Annie **Porter**: Some insect flagellates introduced into vertebrates. Insect flagellates, *e.g. Herpetomonas jaculum*, Léger, from *Nepa cinerea*, and *H. ctenocephali*, Fantham, parasitic in the dog-flea, *Ctenocephalus canis*, can live inside certain vertebrates (*e.g.* mouse and dog respectively), and can multiply therein. This the authors have shown experimentally. If such flagellates be inoculated intraperitoneally or are fed by the mouth in food, the flagellates can find their way into the blood-stream and internal organs (*e.g.* liver, spleen, bone-marrow) of the vertebrate host. The insect flagellates are pathogenic to the vertebrates experimented upon, producing symptoms like those of leishmaniasis (kala-azar). The oval, post-flagellate forms appear to be more capable of developing in vertebrate hosts than are other stages of the herpetomonad parasite of the insect. It may be expected that the various leishmaniases, occurring in different parts of the world, will prove to be insect-borne herpetomoniases.—W. R. **Thompson**: Some notes on insect parasites. These notes deal with the question of the cuticula of the Arthropods as a means of defence against parasites. An attempt was made to show that by its thickness and resistance, by the cuticular appendages such as spines and hairs, and by the process of the moult which is in strict correlation with the development of the cuticula, a very considerable part of the parasitic invasion is arrested. The heavy parasitism to which the Arthropoda are often subject was held to be due in part to the fact that many of the parasites are also Arthropods inhabiting the same environment as their hosts, in part to the structure and physiology of the Arthropods themselves, which offer as hosts an environment especially favourable to the development of parasitic organisms.—G. L. **Purser**: Preliminary notes on some problems connected with respiration in insects generally and in aquatic forms in particular. Aquatic insects were separated into two groups, true and false, according as they made use of the oxygen in the pond-water or not. Among the true group were mentioned Sialis, Gyrinus, and the Trichoptera, which have the simplest type of tracheal gill. The Ephemeridæ and Odonata were shown to have lamellate gills in which a pigment, which has been named Spadicin, is present. No explanation of its function has stood the test of facts except a respiratory one, but evidence for this is indirect only. The blood-gills of Chironomus were mentioned, and the question of the origin of a treacheal system and the problem of ecdysis of the tracheal system in true aquatic forms were discussed.—N. **Wiener**: The shortest line dividing an area in a given ratio.

PARIS.

Academy of Sciences, November 30.—M. P. Appell in the chair.—Gaston **Darboux**: The integration of a partial differential equation of the second order with two independent variables.—André **Blondel**: The calculation of the potential energy of a bobbin through which a current is flowing in the case of winding in place. A bobbin is placed in a magnetic field and a wire, carrying an electric current, is wound on this. No induced E.M.F. is produced, and several theoretical deductions based on this fact are given.—E. **Colardeau**: Method for the exact localisation of projectiles in wounded persons by the radiographic method. The method detailed permits the exact localisation of the projectile within five minutes of the measurement of the photographic plates.—Victoriano F. **Ascarza**: The total eclipse of the sun of August 21, 1914, observed by the Spanish expedition at Theodosia (Crimea). Observations were possible of the second and third contacts and the total phase, but clouds somewhat interfered with the work. Photographs were taken with two spectrographs, one fitted with a Rowland grating, the other with a prism, special attention being given to the infra-red region (see p. 432).—P. **Carrasco**: Physical observations made at Theodosia during the total eclipse of the sun of August 21, 1914.—M. **Fournier**: General conditions of aptitude at high velocities of a hull in navigation.—J. **Bougault**: Indene-dicarboxylic and hydrindenedicarboxylic acids. A study of the condensation of benzyloxalacetic ester with sulphuric acid. The reaction is not analogous with the condensation of the lower homologue, phenyloxalacetic ester; the ester of a new indene-dicarboxylic acid being formed:



$$C_6H_4\begin{array}{l}\diagup CH_2\diagdown\\ \diagdown\!-C=\end{array}\begin{array}{l}C.CO_2.C_2H_5\\ CO_2C_2H_5\end{array}$$

Proofs of this constitution are given.—René **Régamey**: Cancer in plants. Proofs are given of the existence in plants of a cancerous disease differing from Smith's crown gall, spontaneous in the oak, and inoculable into other plants. It is produced by a bacterium capable of isolation and cultivation in artificial culture media. The parasite is intracellular in the tumours.—P. **Carnot** and B. **Weill-Hallé**: Biliculture in typhoid fever. Two alternative methods of obtaining bile from the patient are described. The cultivation of the typhoid bacilli present in the bile is easy, pure cultures being readily obtainable. The course of the disease can be followed, and the method is especially valuable in tracing the persistence of infection in convalescents and typhoid carriers.—Paul **Godin**: a premonitory sign of pulmonary tuberculosis.—F. **Bordas** and M. **Brocq**: Water supply to armies in the field. It is accepted as fundamental that all water drunk should be previously boiled, and the most practical way of ensuring this is to insist that weak tea should be the ordinary drink. For an army of 1,000,000 men, drinking one litre every twenty-four hours, this implies a daily consumption of 15,000 kilograms of tea. The problems of making and distributing the tea at the front are discussed. The same boilers can supply not only water for drinking but warm and sterilised water for the treatment of the wounded.—L. G. **Seurat**: Precocious copulation in Oxyuris.—A. **Sartory** and Ph. **Lasseur**: Contribution to the study of a new pathogenic Oospora (*Oospora bronchialis*). This new organism was isolated from a case in which the most prominent symptom was foul-smelling breath and putrid expectoration. The fungus was shown to be pathogenic to the guinea-pig and rabbit, producing bilateral purulent pleurisy. Treatment with potassium iodide caused marked improvement.—F. **Kerforne**: The systematic position of the deposits of iron ore in the lower Ordovician in the region of Châteaubriant.

BOOKS RECEIVED.

South Australia. A Review of Mining Operations in the State of South Australia during the Half-Year ended June 30, 1914. Pp. 64. (Adelaide: R. E. G. Rogers.)

Department of Mines: Geological Survey of N.S.W. The Great Australian Artesian Basin and the Source of its Water. By E. F. Pittman. Pp. 57. (Sydney: W. A. Gullick.)

Transactions of the Paisley Naturalists' Society. Edited by Rev. C. A. Hall. Vol. ii. Pp. xvi+120. (Paisley: A. Gardner.) 3*s*. 6*d*. net.

Intermediate Practical Chemistry for University Students. By F. W. Atack. Pp. viii+204. (London and Manchester: Sherratt and Hughes.) 4*s*. net.

The Elements of Electro-Plating. By J. T. Sprague. Pp. vii+72. (London: E. and F. N. Spon, Ltd.) 1*s*. 6*d*. net.

Liquid Drops and Globules: their Formation and Movements. By C. R. Darling. Pp. x+83. (London: E. and F. N. Spon, Ltd.) 2*s*. 6*d*. net.

The Dynamics of Surfaces: an Introduction to the Study of Biological Surface Phenomena. By Prof. L. Michaelis. Translated by W H. Perkins. Pp. viii+118. (London: E. and F. N. Spon, Ltd.) 4*s*. net.

Motion of Liquids. By Lieut.-Col. R. de Villamil. Pp. xiv+210. (London: E. and F. N. Spon, Ltd.) 7*s*. 6*d*. net.

An Introduction to the Study of Fossils (Plants and Animals). By Prof. H. W. Shimer. Pp. xiv+450. (London: Macmillan and Co., Ltd.) 10*s*. 6*d*. net.

Iowa Geological Survey. Vol. xxiv. Annual Report, 1913, with accompanying Papers. Pp. xvi+792. (Des Moines: Iowa Geological Survey.)

The Cambridge University Calendar for the Year 1914–15. Pp. xxx+1034. (Cambridge University Press.) 7*s*. 6*d*. net.

Department of the Interior. U.S. Geological Survey. Mineral Resources of the United States. Calendar Year, 1912. Part i., Metals. Pp. 1079. Part ii., Non-Metals. Pp. 1218. (Washington: Government Printing Office.)

Plane Trigonometry and Tables. By G. Wentworth and D. E. Smith. Pp. v+188+v+104. (Boston and London: Ginn and Co.) 5*s*.

Elements of General Science. By Dr. O. W. Caldwell and W. L. Eikenberry. Pp. xiv+308. (Boston and London: Ginn and Co.) 4*s*. 6*d*.

Bergens Museum. Aarsberetning for 1913 og iste halvaar 1914. Pp. 122. Aarbok 1914–15. 1ste Hefte. Avhandlinger og Aarsberetning utgit av Bergens Museum. By J. Holmboe. Skrifter. Ny Roekke. Bind i., No. 2. Studies on the Vegetation of Cyprus. By J. Holmboe. Pp. 344. (Bergen: J. Griegs.)

An Account of the Crustacea of Norway. By G. O. Sars. Vol. vi., Copepoda Cyclopoida. Parts v. and vi., Cyclopidæ. Pp. 57–80. (Bergen: Museum.)

Elements of Forestry. By Profs. F. F. Moon and N. C. Brown. Pp. xvii+392. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s*. 6*d*. net.

American Handbook for Electrical Engineers. H. Pender, Editor-in-Chief. Pp. xviii+2023. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21*s*. net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 17.

ROYAL SOCIETY OF ARTS, at 4.30.—The Indigo Industry: Dr. F. Mollwo Perkin.

INSTITUTION OF MINING AND METALLURGY, at 8.—*Adjourned Discussion*: Persistence of Ore in Depth: T. A. Rickard.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—Notes on the Development of the Trinidad Oilfields: Prof. J. Cadman.

LINNEAN SOCIETY, at 5.—"Witches Brooms," caused by the Gall-mite, *Eriophyes triradiatus*, Nal., on *Salix fragilis*, illustrated by lantern-slides: M. Christy.—The Brent Valley Bird Sanctuary; An Experiment in Bird Protection: W. M. Webb.

FRIDAY, DECEMBER 18.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Audible and Other Cab Signals on British Railways: W. C. Acfield, L. P. Lewis, V. L. Raven, W. A. Stanier, and W. Willox.

WIRELESS SOCIETY, at 8.—The High Frequency Resistance of Wires and Coils: Prof. G. W. Osborn Howe.

PHYSICAL SOCIETY, at 5.—Exhibition and Description of Some Apparatus for Class Work in Practical Physics: Dr. G. F. C. Searle.—A Vacuum Guard Ring and its Application to the Determination of the Thermal Conductivity of Mercury: H. R. Nettleton.

MONDAY, DECEMBER 21.

INSTITUTE OF ACTUARIES, at 5.—Canadian Mortgages Regarded as a Field for the Investment of the Funds of British Life Assurance Companies, with some General Notes on Canadian Indebtedness: A. D. Besant.

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THURSDAY, DECEMBER 24, 1914.

ROGER BACON AND GALILEO.

(1) *The Life and Work of Roger Bacon.* An Introduction to the Opus Majus. By J. H. Bridges. Pp. 173. (London: Williams and Norgate, 1914.) Price 3*s.* net.

(2) *Roger Bacon.* Essays contributed by Various Writers on the Occasion of the Commemoration of the Seventh Centenary of his Birth. Collected and edited by A. G. Little. Pp. viii + 426. (Oxford: Clarendon Press, 1914.) Price 16*s.* net.

(3) *Dialogues Concerning Two New Sciences.* By Galileo Galilei. Translated from the Italian and Latin into English by Henry Crew and Alfonso De Salvio. Pp. xxi + 300. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

THE seventh centenary of Roger Bacon's birth has been happily signalised by the republication in a separate handy volume (1) of the admirable "Life and Work" which the late Dr. Bridges prefixed to his edition of the "Opus Majus"; and by the issue from the Clarendon Press of a collection of essays (2) by eminent specialists, British and foreign, dealing with the different aspects of Bacon's work. To this volume the editor, Mr. A. G. Little, contributes an introductory life, valuable both for its own sake and because the author quotes at length a lucid and judicial estimate of Bacon from a lecture by the late Prof. Adamson.

Dr. Bridges's volume is, perhaps, the best estimate in short compass of Bacon's work and significance. The Oxford essayists follow practically the same order of topics, but treat them in greater detail;—Bacon's indebtedness to Robert Grosseteste (Dr. Baur), his relation to thirteenth century philosophy (M. Picavet), to philology (Dr. Hirsch), the Latin Vulgate (Cardinal Gasquet), mathematics (Prof. Eugene Smith), optics (Prof. E. Wiedemann), alchemy (Mr. Pattison Muir), medicine (E. Withington). Dr. Vogl discusses Bacon's curious theory of the transmission of force in the "De Multiplicatione Specierum"; Prof. Duhem shows wit as well as learning in his amusing history of the principle that nature abhors a vacuum; and Colonel Hime deduces from the ninth, tenth, and eleventh chapters of the "Epistola de Secretis Operibus," unintelligible as they stand, the complete Waltham Abbey formulæ for the refinement of saltpetre and manufacture of gunpowder, by methods which must delight the Shakespeare-Baconians or the admirers of Poe's "Gold Bug."

It is easy to exaggerate Bacon's actual achievements. These masterly essays leave the impression that he made few, if any, positive additions to science. "He gives no evidence of his own proficiency in calculation, nor does he show any conception of the nature of algebra." In geometry "he distinguishes between axioms, postulates, and definitions . . . but he makes no attempt to advance the science or to prove a single theorem." One-fifth of the "Opus Majus" is devoted to optics, but apparently he did little more than reproduce the Arabian tradition through Alhazen, with references to the Greek school of Euclid and Ptolemy. Though he quotes from Philo of Byzantium and Hero of Alexandria the classical experiments of the "chantepleure" and the adhesion discs, he argues the question of the vacuum as a pure Aristotelian and accepts without trial the supposed experimental fact that no power on earth would suffice to lift an inverted glass out of a bucket of water without first tilting the edge to admit air. "On aime à faire de Roger Bacon un adepte précoce de la méthode expérimentale; des pages comme celles-ci nous montrent assez qu'il expérimentait seulement en imagination." It does not do to read into his doctrine of the "Multiplication of Species" a forecast of the wave-propagation of light through the æther; or into the famous passage where he seems to anticipate the steam engine, the aeroplane, and the submarine more than a conviction, quite remarkable for his day, that the proper study of nature would work miracles in the service of man.

Bacon's greatness rests on other grounds. A good Catholic, he was yet of the pestilent class of innovators. He attacked authority. His strong character and original mind set about shaking itself free from the "horse-load" of verbal controversies that filled the schools of his day. He was no mathematician and not much of an experimenter; but it is his immortal glory that he was the first to state explicitly the true method of science, the union on equal terms of mathematics and experiment, with deeper insight than his great namesake who, three hundred years later, thought only of experiment and classification, ignoring the use of deduction. He urged the study of languages and philology in order to provide accurate texts of the Bible and Aristotle, denouncing in unmeasured terms the vices and luxury of the clergy, the stupidity of the philosophers content with their barren summaries and versions by those who knew neither the language of their authors nor the subjects they wrote about. He even dared to find many of the Christian virtues among the wise men of Arabia and the East, and valuable stores of knowledge unknown to Aristotle. It was the aim of his life to sweep all this intellectual treasure house into the service of the church.

"He was aiming at an enlarged and renovated Catholicism," says Dr. Bridges, "which should bind together and incorporate all that was best and noblest in Hebrew, Greek, and Arabic tradition in the fabric of the Christian Church, for the spiritual government of the world. The keystone of the fabric was supplied by the mistress-science, theology, resting on Mosaic and Christian revelation, consolidated by Aristotelian philosophy, and penetrated by the vital and progressive spirit of natural science."

Profs. Crew and de Salvio have done a great service in their admirable translation (3) of Galileo's less-known dialogues, "Concerning Two New Sciences," *i.e.* strength of materials and dynamics. For though it is Galileo's astronomical work, with its dramatic consequences to himself, which sticks in the popular imagination, he stands among the greatest of the pioneers rather by reason of his advances in mechanics. He was the founder of modern physics, the first to put in practice the method urged by Roger Bacon, where mathematics and experiment go hand in hand.

This book should be in the hands of all teachers and, better still, of all students of mechanics. In the cut and dried text-book, the science leaps to birth full-armed in its panoply of dry propositions; but here we see it emerging step by step at the touch of genius from the very problems of practical life from which it took its rise, and the gain in reality is beyond belief. These are real dialogues, between Salviati, who represents Galileo's views, Sagredo, a wit and scholar, and Simplicio, an Aristotelian philosopher. The conversations are natural, discursive, yet closely reasoned. The Aristotelians are given more than fair play, for Galileo puts into Simplicio's mouth better arguments than they had advanced themselves. The inimitable style, with its lucid simplicity, its flashes of humour and sarcasm, gives the same instant impression of modernity that one gets on dipping after a long interval into one of Plato's dialogues. It loses nothing in the translation, where occasional racy Americanisms—"on time," "cuts no figure," "cut loose from"—seem quite in place.

The lapse of three hundred years is vividly realised in passing from Roger Bacon's scholastic Latin to these conversations that might have appeared in a modern review; from the dim, though explicit, formulation of the true method to its full and easy employment. Here is complete mathematical equipment (of the time) and every deductive conclusion is instantly put to the test of experiment. And surely the experiments are among the simplest and most truly elegant of all time. The guess that the speed acquired by bodies falling down inclined planes between two fixed horizontal levels is the same for all slopes and just sufficient to carry them to the original level *up any slope* (for otherwise a body might be made to lift itself unaided above its level) is tested by the most beautiful experiment of all—where the pendulum is set swinging and when the string is intercepted by a nail fixed at any height, the bob is found always to rise to the same level whatever circle it is compelled to pursue. Here, too, is the immediate inference of the First Law of Motion. For if the slope up which the body travels towards its original level is gradually reduced to the horizontal, *it will never get there*, and will therefore go on for ever, being now under the action of no forces!

There follows the famous discussion of falling bodies. The change of the point of view is at once apparent when the fruitless question *why* they fall is set aside until it is found *how* they fall. Simplicio suggests the natural view that the speed acquired is proportional to the distance fallen. But this is shown to be an impossible form of motion, since it implies that it takes as long to fall an inch as a mile. Is it then proportional to the time? In that case it is shown that the distance is proportional to the square of the time; and this is verified by the experiment of the inclined plane and water-clock. One wonders whether most to admire the theoretical insight or the experimental skill. Gravity, therefore, adds equal speeds in every second, however fast the body is moving. This is at once extended to the case of a body projected *across* gravity, horizontally, and the whole theory of the parabolic path of a projectile is deduced. The dialogues are full of interesting digressions, *e.g.* on various orders of infinity (worthy of modern transcendentalists), terminal velocities, brachistochrones, vibrations of stretched strings, the theory of harmony and discord. What a genius!

There are parallels as well as contrasts between these two great men. Both were so convinced of the value of experience that they sought to learn from common people. Thus Bacon, speaking of Peter of Maricourt:—

"One man I know, and one only, who can be praised for his achievements in this science. . . . He is ashamed that any things should be known to laymen, old women, soldiers, ploughmen, of which he is ignorant. Therefore he has looked closely into the doings of those who work in metals and minerals of all kinds." And again, "They are willing to lower themselves to the level of husbandmen, of poor women, of children. Many things are known to the simple and unlearned which escape the notice of the wise."

In this spirit Galileo opens his dialogues:—

"The constant activity which you Venetians display in your famous arsenal suggests to the studious mind a large field for investigation, especially that part of the work which involves mechanics; for in this department all types of instruments and machines are constantly being constructed by many artisans, among whom there must be some who, partly by inherited experience and partly by their own observations, have become highly expert and clever in explanation."

Three hundred years again, and Faraday, perhaps Galileo's only superior as an experimenter, writes down:—

"Whilst passing through manufactories . . . we are constantly hearing observations by those who find employment in those places, and are accustomed to a minute observation of what passes before them, which are new or frequently discordant with received opinions. These are generally the result of facts, and though some are founded in error, some on prejudice, yet many are true and of high importance to the practical man. Such as come in my way I shall set down here, without waiting for the principle on which they depend."

This is indeed the scientific spirit, a long, long way from the schoolmen!

Both Bacon and Galileo were good Catholics, and both had sympathisers among the magnates of the Church, including the Popes. Yet both were imprisoned and had their teaching condemned, and both may be said to have forced their own imprisonment. Relying on their protectors in high places they attacked the orthodox teaching of their times, and with characteristic weapons, Bacon with the bludgeon of savage invective, Galileo with the rapier of irony and sarcasm. Yet though suppressed for the moment, their work was not in vain. It was a passage from the "Opus Majus," quoted verbally in Pierre d'Ailly's "Imago Mundi," which Columbus cited as one of his inspirations to the discovery of the New World, and his proposals for the reform of the Calendar bore fruit in the sixteenth century. So, too, when Milton found Galileo practically a prisoner at Arcetri, old, bereaved, grievously ill and blind, it might have seemed that the powers of obscurantism had prevailed. But the very year when he lay broken and dying there was born in Lincolnshire a child, Isaac Newton, who was destined to bring his work to a triumphant conclusion and place him on a pinnacle of glory. You cannot crush the human spirit. In these days we may take courage from these two great men, for even though freedom should be trodden under the iron heel of military despotism, which God forfend, it will revive again, and this time it will not wait three hundred years for its resurrection.

TOOTH OF MAN AND BEAST.

A Manual of Dental Anatomy, Human and Comparative. By Dr. C. S. Tomes. Seventh Edition. Edited by Dr. H. W. Marett Tims and Prof. A. Hopewell-Smith. Pp. vi+616. (London: J. and A. Churchill. 1914.) Price 15*s.* net.

If one imagines, for tableau representation, a quickening of the action in the slow-moving epic of organic evolution, a forward position of immense significance was surely in sight when the scaly armour of certain fishes became so elaborated that they went forth muffled in spines to the very lips. And the defence and protection was completed—and something more than these was initiated—when the dermal spines were drawn over the lips and carried into the mouth itself, there to form the beginnings of those wonderfully diversified structures which are known as teeth. Many eminent workers have, along various byways of inquiry, been attracted to, and held by, the study of odontology, and have helped to build up a most noticeable body of scientific knowledge. Tomes's "Dental Anatomy" still holds the field as, perhaps, the most successful effort to gather and arrange the facts, and present them in a "manual" suitable for students and beginners. The author and his editors are to be congratulated upon the production of the seventh edition, in which the make-up is improved by a larger page and type, and by bringing the matter descriptive of illustrations directly under each figure, instead of at the foot of the page.

The desire of the editors "to incorporate in the volume the results of recent research" has not brought about the addition of much new matter. But the ordinary student is not likely to be found grumbling before such a well-spread table; the number of published "note-books" and compilations of the "cram" order that have sprung from the parent work of Tomes shows that he suffers gladly any reduction of bulky fare. The acute controversies that turn upon such problems as enamel formation, dentine innervation, and the homologies of teeth, remain apparently unsettled, and in regard to these and many other disputed points there may be some disappointment that, after the lapse of a decade, the very wide catholicity of Mr. Tomes's interesting discussions has not now been amended in the direction of more definite leading and instruction. Now and then the accepted facts are so entangled in lengthy argument—of historical interest merely—that the student must have difficulty in picking them out.

The chapter on the development of the jaws is brought up to date by the inclusion of a section prepared by Prof. Fawcett, giving the results of his own recent investigations. The editors may not yet have noticed that the end of this excellent *résumé* is wrongly indicated by misplaced quotation marks. In another part of the same chapter, on p. 237, the omission of "so that" from the beginning of the sixteenth line is probably unintentional. The statement that the first permanent molar of man makes its appearance "about the eleventh year" is an example of the undetected clerical slip that occasionally bears a charmed life through successive editions.

In regard to the difficulty of deciding what teeth may be missing in dentitions that are reduced in number from the so-called "typical" mammalian formula, Dr. Marett Tims has added a useful reminder: "It is doubtful whether the homologies of the teeth, when one or more of the series is absent, can be correctly interpreted from an examination of the skulls of adult animals, whether recent or fossil." In order to determine the position of any tooth vestiges present, a microscopical investigation of the developing tooth should (he says) be made whenever possible. The same writer contributes a series of diagrams which indicate clearly the number of dentitions represented in the various groups of the mammalia.

Mr. Tomes's criticism of the well-known Cope-Osborn theory of the evolution of mammalian teeth has, in the present edition, been qualified by one or two editorial notes presaging a more diminishing belief in the doctrine of trituberculism. Cope's *kinetogenesis* idea of the evolution of tooth forms, either by a sort of plastic yielding, or a stimulus to the formation of new cusps at the points of the greatest wear, can scarcely be thought to have survived the disintegrating objections clearly and restrainedly put forward by Tomes. In the second part of this edition, the arrangement of the orders has been altered and brought somewhat nearer to a logical sequence. The teeth of primates are dealt with in the last chapter, and here are placed tentatively—yet with a painstaking attention to the honourable rights of precedency—the five or so known types (including the recently-discovered *Eoanthropus dawsoni*) that lie upon or near to the line of descent of later man. Adjudgment of the conflicting claims of these "poor relations" to be the direct ancestors of modern man is a most difficult matter. The subject is naturally a widely attractive one, so that when discussions of it are forward even those not ordinarily concerned with dental science will prick an ear and often draw near to take a hand. But when, as often happens, the clues to the interpretation of fragmentary remains of man or animal have to be sought mainly in the imperishable teeth, the very fullest available knowledge of all the tooth tissues must be applied to the problem.

In the sifting and evaluation of evidence, many of Tomes's discussions are models of scientific criticism. His handling of debatable subjects is marked also by a literary style of charm and flexibility, in which he moves smoothly and easily forward towards a concentration on the essential or significant points. It can safely be said that responsibility for the editorship of this new edition has fallen into competent hands. While that is so, many will hope that Mr. Tomes may continue to hold at least a watching brief for odontology.

ECONOMIC ENTOMOLOGY FROM WEST AND EAST.

(1) *Manual of Fruit Insects.* By the late M. V. Slingerland and C. R. Crosby. Pp. xvi+503. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s*. 6*d*. net.

(2) *Indian Forest Insects of Economic Importance: Coleoptera.* By E. P. Stebbing. Pp. xvi+648+lxii plates. (London: Printed by Eyre and Spottiswoode, Ltd.; sold by Constable and Co., Ltd., and others, 1914.) Price 15*s*.

(3) *Crop Pest Handbook for Behar and Orissa (including also Western Bengal).* Department of Agriculture, Behar and Orissa. Pp. xxiii+Leaflets 84+Appendices 21+plates liv. (Calcutta: Thacker, Spink and Co., 1913.) Price 4 rupees.

(1) STUDENTS of applied entomology all the world over remember gratefully the late Prof. M. V. Slingerland, whose writings in the Bulletins of the Cornell University of Ithaca and elsewhere, form a storehouse of information on insect life-histories and on practical means for destroying pests. And now Mr. C. R. Crosby has completed the pious task of editing a quantity of manuscript left unfinished by Slingerland when, five years ago, he was taken from us. The result of this collaboration is a handy volume in which two hundred species of orchard insects common in the United States are described and figured. In the space allotted the descriptions are

necessarily brief, but many facts are conveyed in short paragraphs—thanks to a plain and effective style—while references are given to special memoirs. As might have been expected, the literature quoted is entirely American, though not a few of the insects described are common European pests on which some useful observations have been made on this side of the Atlantic. European workers, however, will be glad to have the American experience with regard to these species, and to others which are near allies of common "old-world" kinds. The few pages of "general considerations" on the structure of insects are the weak part of the book; it is disappointing to see the cuticle called a "shell" on p. 2 and a "skin" on p. 5. The concluding chapter deals with the practical use of insecticides. Illustrations comprise nearly four hundred figures, some of which are reproductions of excellent drawings, while the rest are photographs of somewhat unequal value. Indeed, examples of extremes of merit and demerit in natural history photography might be drawn from this volume.

(2) Mr. E. P. Stebbing, who not long ago left the Indian Forest Service to become head of the Forestry Department of Edinburgh University, has provided in this handsome volume a worthy monument of his work in the East. His "Manual of Elementary Forest Zoology for India," published in 1908, was noteworthy for many original observations on the life-history of Indian forest beetles. The present work—a large royal octavo of more than 600 pages, with 63 plates and 400 text-figures—is entirely devoted to those Coleoptera which are known to be of economic importance in Indian forests. The arrangement is systematic, the large series of beetles described being set forth by their families; it is to be regretted that the grouping of the families is that given by Dr. D. Sharp in the "Cambridge Natural History," a grouping the convenience of which does not atone for its artificiality. In the details of his systematic work Mr. Stebbing has wisely sought help from a number of specialists, for no one man can nowadays deal effectively with all the members of a great insect order from an extensive tropical region. Messrs. C. J. Gahan and G. Arrow of the British Museum, Mr. G. Lewis, Col. F. W. Sampson, Mr. G. A. K. Marshall of our Imperial Bureau, M. P. Lesne of the Paris Museum, and M. G. Severin of the Brussels Museum are among those who have identified, and where necessary described, specimens of their favourite families. The classificatory work may therefore be relied on, and with Mr. Stebbing's accounts of life-histories, habits, effects of the insects on trees, and relation of the insect fauna to the forests in a wide sense, a mass of valuable information is here gathered for the Indian student of the present and the future. As to the illustrations, most of the photographic reproductions are beautiful, and, with the exception of a few rough sketches, the drawings may be highly praised.

(3) A volume consisting of a number of leaflets, briefly describing common crop pests of Behar, Orissa, and Western Bengal is introduced by a preface by Mr. E. J. Woodhouse; he tells us that the work has been compiled by Mr. S. K. Busu, who is responsible for the few fungi that are included, and Mr. H. L. Dutt, who deals with the insects. Among the latter the presence of *Pieris brassicae, Aphis brassicae,* and other well-known British crop-pests is interesting. The leaflets are of quarto size, each being illustrated by an admirably printed coloured plate. These plates, which, we are told, "have not been previously published, but are intended for use in memoirs in course of preparation by the Imperial Entomologist," will doubtless make it easy for the Indian farmer to identify his insect enemies. They will also prove of no little service to the working entomologist.

G. H. C.

TEXT-BOOKS OF CHEMISTRY.

(1) *Chimie Physique Elementaire.* By E. Aries. Tome Premier. Les Principes Generaux de la Statique Chimique. Pp. xxx+212. (Paris: A. Hermann et Fils, 1914.) Price 4 francs.

(2) *A Manual of Practical Physical Chemistry.* By Dr. F. W. Gray. Pp. xvi+211. (London: Macmillan and Co., Ltd., 1914.) Price 4*s*. 6*d*.

(3) *Notes on Elementary Inorganic Chemistry.* By F. H. Jeffery. Pp. iv+55. (Cambridge University Press.) Price 2*s*. 6*d*. net.

(4) *The Elements of Chemistry.* By H. L. Bassett, with an introduction by Prof. W. J. Pope. Pp. xii+368. (London: Crosby Lockwood and Son.) Price 4*s*. 6*d*.

(5) *Chemical Calculations.* Pp. vi+136. *Chemical Calculations (Advanced Course).* Pp. vi+48. By H. W. Bausor. (London: University Tutorial Press, Ltd., 1914.) Price 2*s*. and 1*s*. respectively.

(6) *The Fixation of Atmospheric Nitrogen.* By Dr. J. Knox. Pp. vii+112. (London: Gurney and Jackson, 1914.) Price 2*s*. net.

(1) THE French text-book of physical chemistry would scarcely be regarded in this country as justifying the author's description of it as "elementary." It is essentially an exposition of the work of Willard

Gibbs, with additional theorems and applications developed by the author. Although the book deals with such familiar subjects as chemical equilibrium, the laws of mass action, the phase rule, and osmosis, it does not descend to the discussion of experimental facts, and contains no illustrations of apparatus, no tables of data, and none of the usual graphical representations of equilibria. On the other hand, the mathematical treatment of the problems is very thorough and exact. The book will not be likely to attract the average chemist, who prefers to make use of theories only when they can be kept closely in touch with experiment; but a student who had taken an "honours" degree in mathematics would probably enjoy a course of chemistry in which theory reigns supreme and the limitations of experiment are thrust into the background, or perhaps postponed to a later volume of the series.

(2) Dr. Gray's "Practical Physical Chemistry" contains a series of thirty-nine exercises, which may be carried out by individual students in periods of two to three hours. It is undoubtedly one of the best books of the kind that has yet been published. The exercises deal with real problems and with real apparatus, in a way that should bring the student into touch with modern methods of exact measurement, and make it easy for him to proceed to original work in physical chemistry if the opportunity should arise. The preliminary discussion on "Accuracy" is particularly welcome, and should provide a useful check on the slovenly and inexact measurements which are the chief menace to the success of a course of experimental work in physical chemistry.

(3) Mr. Jeffery's "Notes" are a series of summaries of the data that are necessary for answering ten of the questions that are most commonly set in examinations on chemistry, *e.g.* on acids, salts and bases, oxides, oxidation and reduction, electrolysis, etc. To the student preparing for examinations the advantage of having these data in a compact form will be obvious, though he might well expect to find most of the information in a general text-book. The compilation has been done carefully, and criticism may be confined to points of detail. Thus, it is curious to find no reference at all to the sour taste by which acids first acquired their reputation, although their action on litmus and their electrolytic properties are described; the reader is also not told whether the solubility of metallic hydroxides in caustic alkalies brings them within the category of acids or not. It is, however, satisfactory to find that the author has realised the difficulty of *defining* acids, salts, and bases, and is for the most part content with *describing* their characteristic properties; such a description might well be made into a historical statement showing the gradual development of the idea of an "acid" in the hands of Lavoisier, Berthollet, Gay Lussac, and Laurent, and of a "salt" in the hands of Boyle, Lavoisier, Berzelius, Laurent, and others. In dealing with students, it is a pity to allow them to "obtain" common salt by mixing caustic soda and hydrochloric acid, and to regard this as a "preparation" of the salt; an exercise on the recrystallisation of rock salt or the extraction of common salt (and Epsom salts) from sea-water would be of greater value, and much more in touch with reality.

(4) Mr. Bassett's book is intended for medical and dental students who require to obtain within the course of a single year some knowledge both of inorganic and of organic chemistry. The requirements of such a syllabus are in no way incompatible with a sound scheme of instruction; the study of alcohol, for example, affords excellent material for explaining methods of purification, tests of purity, and the fundamental principles of analysis in a course of general chemistry. Roscoe's "Lessons" may be quoted as a very successful example of a combined course of inorganic and organic chemistry; but the medical student of the present day has been somewhat badly served in the matter of text-books, and Mr. Bassett's book is an attempt to fill a gap that is recognised clearly by those who are responsible for the teaching of medical and dental students.

In spite of certain merits that the book possesses, it is doubtful whether it will secure any extensive foothold in the medical schools. Actual experience shows that it is a mistake to discuss the periodic classification of the elements before any of them have been studied in detail. Moreover, this classification is not a suitable basis for an introductory study of the elements. The author has boldly adopted it, and described the elements in the order in which they occur in Mendeléeff's table. He therefore postpones the consideration of oxygen and chlorine until all the metals, except those of the iron-group, have been described. Here again, as experience shows, he has made a fatal mistake, and not one student in a hundred is likely to benefit by using the scheme which the author has adopted.

Whilst most of his statements are accurate, the author has admitted several errors, from which the student might reasonably expect to be protected. He would be unwise, for example, to assert with the author that barium monoxide is prepared by heating the carbonate, or that in a combustion oxygen is *drawn* through the apparatus. The definitions of acids, bases, and salts are novel, but altogether bad. If they could be taken literally, they would include amongst the bases such diverse substances as oxygen, phosphorus, potassium permanganate, sugar, alcohol, camphor, benzene, toluene, formic acid, oxalic acid, since all these substances can "react with an acid, giving water as one of the products." Amongst the "salts" one would find chlorine, phosphoric acid, oxalic acid, ethyl acetate, ethylene, ether, camphoric acid, nitrobenzene, benzoic acid, carbon monoxide, and carbon dioxide, since each of these may appear in the guise of "substance, other than water, produced by the reaction of an acid and a base," as defined in the opening sentences of the chapter.

(5) Mr. Bausor's two books on chemical calculations may be commended on the ground that the problems bear a very close resemblance to those that would be met with in the actual experience of a chemical worker. No further commendation is needed except to say that the range of subjects and the working out of typical problems are alike satisfactory. The only improvement that may be suggested is to the effect that greater interest would be aroused and more useful information imparted incidentally if the author had drawn more freely on numerical data taken from classical experiments, such as those of Berzelius and of Stas, together with more modern experiments by Morley, Richards, Morse, Guye, and others.

(6) Dr. Knox's monograph on the fixation of nitrogen includes a great deal that has become very familiar in recent years, but the subject has been treated in a very satisfactory way. In addition to the well-known details of the Birkeland-Eyde process, ample space is devoted to the theory of the operations and to the many scientific experiments that have been made to elucidate them. The section on the ammonia equilibrium is particularly welcome, in view of the fact that this method of fixing nitrogen has been exploited in the technical Press to a much smaller extent than the processes described in the other two sections of the book. It is not usual to permit any detailed study of technical processes in an elementary course of chemistry, yet nothing but good would result if this little monograph were added to the curriculum of such a course; the problems with which it deals are so important and the underlying theories are so illuminating that they might well be used to add an element of romance and a new interest to the oft-told story of elementary inorganic chemistry.

T. M. L.

OUR BOOKSHELF.

Pattern-making. By F. W. Turner and D. G. Town. Pp. v+114. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 4*s*. 6*d*. net.

This little book is intended for young pattern-makers, and presents a general survey of the most suitable materials, the special tools, and the fundamental processes of the trade, together with the relations of the pattern-shop with the allied departments, viz., the drawing office, the foundry, and the machine shop. The pattern-maker is principally concerned with the foundry, and throughout the book we find clear and concise descriptions of moulding processes, well-illustrated, together with discussions of the sometimes conflicting requirements of the moulder and pattern-maker, and explanations of the compromises which have to be adopted. In recent years the development of machine tools, both in the foundry and in the pattern-shop, has altered considerably the art of pattern-making and also the stock of hand-tools composing the private equipment of the artisan.

The book contains many interesting devices which have been developed by American workmen for special purposes, and in this respect will be found to be of considerable interest even to older pattern-makers in this country. A special word may be said regarding the illustrations in the book; these are excellent, both as regards the selection of typical examples and also clearness of drawing and reproduction.

We can confidently recommend the book to young pattern-makers and others connected with engineering, not that it will make them good pattern-makers—experience alone will produce this result—but on account of the broadening of views which is sure to be acquired during the perusal of its pages.

Foundations: a Short Text-book on Ordinary Foundations, including a brief description of the methods used for Difficult Foundations. By Prof. M. A. Howe. Pp. vii+110. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 5*s*. 6*d*. net.

In this book the author has treated in an elementary manner both the fundamental principles involved in the design of foundations and also standard methods of carrying out the actual work. Special treatment is given of the footing courses of structures, these being considered apart from the foundation proper. The Rankine theory is adopted for the permissible bearing pressure on soils, and a modified form of Rankine's formula is given; there is a brief discussion of the precautions which must be considered in dealing with various descriptions of soil. Several different methods of construction in the footing courses are given, such as concrete, brick, reinforced concrete, grillage, I beams, and cantilevers; these are clearly described, and the student will have no difficulty in following the methods of calculation. A feature of the book consists in worked-out examples of each case; these will be found to be of great service to the reader. The treatment of the design and driving of piles is good and up-to-date, as is also that of bridge piers and abutments.

The book possesses the merit of presenting a fairly complete exposition of a rather difficult subject without unnecessary profusion of detail, and will be welcomed by many students who desire more information regarding foundations than is to be found in the text-books dealing with the theory and design of structures generally.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Camera in Australia.

Now that most members of the overseas party of the British Association have, happily, returned safely from the meeting in Australia, it seems opportune to remind members of the scheme for the exchange of photographic prints announced in the *Journal* (issued in Melbourne on August 12, 1914, p. 2), for which Dr. A. Holt and myself became responsible. The aim of the scheme was to economise our stock of plates and to prevent unnecessary duplicating of prints. Thus in the advance party in West Australia one member took a photograph of one striking object, a second member of another, on the understanding that all members of the party would be able to obtain, at their own expense, copies of the prints of the photographs, either by an exchange of photographic prints taken by themselves or by payment of the cost of the print supplied. It was an essential feature of the scheme that the photographers themselves should not suffer financial loss in meeting the requests of members for prints.

The scheme is sufficiently comprehensive to include not only illustrations of plants, animals, and scenery, but also of any features appealing to members specially interested in any one of the many Sections of the Association's activities. Thus timber felling, aboriginal camps and their life, manufacturing processes, as well as the lighter side of our visit, such as life on board ship and garden-parties, come within the scheme of exchange. In fact, if any member has photographs of interest taken either in Australia or on one of the many routes members followed to and from Australia it is hoped he will be willing to offer prints of the same to others. Though the scheme was intended in the first instance to apply to members of the overseas party and to local members of the Australian meeting, there is nothing to prevent it from developing so that members of the Association who were unable to attend the meeting may have the opportunity of obtaining a set of the photographic prints offered for exchange.

Will members willing to participate communicate with me as soon as possible? In each case a list of the prints available, together with the address of the supplier and the cost of the prints, should be given. It would be helpful if a set of the prints could also be sent for inspection and subsequent return.

From these lists a general list will be prepared and sent to each participator in the scheme. It will probably be an advantage to all concerned if the exchange is worked from one centre. This we shall be willing to undertake in the hope that all will co-operate by promptness of reply in making the task as light as possible.

It is hoped that the series of prints will serve not only as a permanent record of our unique and delightful experience, but also as illustrative material for teaching, lecture, and museum purposes. Thus members could at this moment help many deserving charities by giving lectures on Australia with these prints for illustration. T. JOHNSON.

Royal College of Science, Dublin.

Magnetic Disturbances, 1913.

DR. W. N. SHAW has asked me to send you an account of an examination, undertaken by his instructions, of the Eskdalemuir magnetograms for 1913. The examination indicates that the disturbances from the level of the quiet day inequality fall into two distinct classes A and B.

A.—The disturbance was due to a magnetic force which remained in a more or less fixed direction while changing sign in an oscillatory manner. Throughout the year the direction of this force had an azimuth lying within a range of about 60° on either side of the magnetic meridian and an inclination to the horizontal lying within the narrow limits 0° and 6°. The slope was upwards towards the more northerly end. An especially clear example occurred on March 23d., 14h. to 18h.

Pulsations of periods 2 to 15 minutes fall into this class. A search also brought to light longer periods of 19, 23, and 26 to 30 minutes. Beyond this there are measured periods of 180, 155, 148, 109, 100, 95, 85, 80, 80, 78, 74, 66, 60, 38 minutes, but the measurements have been uncertain to, say 15 per cent., and should perhaps be taken only to indicate the existence of actual periods near 79 minutes and between 150 and 180 minutes. The crowding together of the shorter periods of 2 to 15 minutes is suggestive of a harmonic series. The longest periods noted were recorded on the afternoons or evenings of June 17d., 21d., 23d., July 9d., 10d., 12d., 15d., 18d., 25d., August 7d., 9d., 11d., 28d. Class A appears to resemble the type of disturbance that Birkeland has attributed to a ring-shaped electric current encircling the earth at a great height above the ground in the plane of the magnetic equator. The periods noted above are enormously greater than the time (0·13 second) taken by an electromagnetic wave to travel round the earth. Similarly the wave-length of sodium light is enormously greater than the circumference of the sodium atom. Can there be a similarity of explanation in the two cases?

B.—The direction of the disturbing magnetic force was not fixed as in class A, but wandered about, usually remaining within 60° of a plane normal to the undisturbed force. The large, slow "bays" near midnight usually fell into this class. For example, the bays on October 7d., 0h. to 4h. Sometimes the disturbing force rotated as if it were rigidly attached to an axis nearly coinciding with the direction of the undisturbed force; the rotation was clockwise to an observer looking north and down. Class B appears to resemble the types of disturbance which Birkeland has called "polar" and "cyclo-median."

Class A disturbances sometimes occurred without class B, but class B seldom occurred without A.

Disturbances of the A class were identified by viewing the traces of the components laid over one another and pressed against a window-pane. The correspondence of the oscillations in the three components determined the matter.

Further particulars will be published in the British Meteorological and Magnetic Year Book, part iv. 2, 1913.

It will be interesting to know whether other observers have found corresponding phenomena in working up records for 1913. L. F. RICHARDSON.

The Observatory, Eskdalemuir, Langholm,
Dumfries-shire, December 11.

THE QUATERNARY ICE AGE.[1]

THIS handsome volume is a notable contribution to the voluminous literature relating to glacial geology. Its scope is comprehensive, for it describes in a crisp and lucid form the succession of Glacial and post-Glacial deposits in Europe and North America, the living and extinct Quaternary mammals, the successive stages of culture of Palæolithic and Neolithic man, the various theories of the cause of the Ice age, and the isostatic theory of the Quaternary oscillations of sea-level. Much controversial ground is traversed in this wide field. Throughout the volume the author maintains a critical attitude and expresses his opinions freely. His chief aim has been to set forth what he regards as the solid basis of fact which throws light on the history of this fascinating epoch. Hence he discards classifications which, in his opinion, are not supported by conclusive evidence.

At the outset the potency of glacial action in modifying the surface features of a country is recognised. In proof of this contention reference is made to the over-deepening of valleys, the formation of mountain corries, the recession of corrie cliffs by sapping, and the excavation of rock basins due to differential erosion in harder and softer rocks. In the preliminary account of the Glacial drifts the opinion is expressed that many erroneous conclusions regarding the retreat and re-advance of the ice and the occurrence of inter-Glacial periods have been based on intercalations of sand, gravel, and clay between sheets of Boulder Clay. The so-called "Upper Boulder Clay," in many instances, may be merely englacial moraine, which settled down on sub-glacially-formed sediments on the disappearance of the ice. On the other hand, it is admitted that, where these intercalated deposits preserve their horizontality over wide areas, they probably point to retreat and re-advance of the ice. Their inter-Glacial value must be determined by local circumstances.

FIG. 1.—The Arctic Fox (*Vulpes lagopus*) in winter coat. From a specimen in the British Museum. From "The Quaternary Ice Age."

The author's attitude towards the inter-Glacial question is clearly defined. He is of opinion that the elaborate systems of the older inter-Glacialists may all be set aside as unproved, and that we ought to accept the mono-Glacial hypothesis until we can prove one inter-Glacial period. Nevertheless instances are adduced which prove oscillations of climate of more or less magnitude. The recent researches of Victor Madsen, Nordmann, and Harz on the Cyprina Clays of Denmark, North Germany, and Holland, furnish satisfactory evidence. These fossiliferous deposits occur as transported masses in the Boulder Clay in the east of Denmark and north of Germany, while to the west and south of these areas they are to be found in their original position, resting on Boulder Clay and fluvio-Glacial gravels. Therefore they cannot be pre-Glacial. They must have been laid down during a period of recession of the ice. In view of the width of the belt containing transported masses of these Eemian deposits in the Boulder Clay of the Baltic ice sheet, the extent of the recession cannot be less than fifty miles. But the presence of well-marked southern species in the marine fauna may indicate a greater recession, and probably the complete disappearance of the ice. These investigations confirm the opinion of Prof. James Geikie and others who assigned these deposits to an inter-Glacial period.

The series of Glacial and inter-Glacial periods worked out by Penck and Brückner in the Alps is adopted. Special allusion is made to certain inter-Glacial deposits proving oscillations of climate, such as the "Höttinger Breccia," the "Schieferkohlen" of Dürnten, the plant-bearing beds of Re and Pianico, all of which are doubtfully referred to the Riss-Würm inter-Glacial period. It is further shown how the evidence from plant remains is confirmed by the Quaternary fauna occurring in Alpine lands; the twofold repetition of the arctic fauna comprising the mammoth, woolly rhinoceros, and reindeer, being separated by the inter-Glacial fauna with *Elephas antiquus*, Merck's rhinoceros, and the red deer.

In the description of the American drifts the classification presented is not so comprehensive as that of Prof. Chamberlin. It begins with the Kansan Till sheet and ends with the later Wisconsin Boulder Clay. The cautious attitude of the author in dealing with the classic Don valley section near Toronto scarcely does justice to the evidence indicating great climatic changes so well described by Prof. Coleman.

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[1] "The Quaternary Ice Age." By W. B. Wright. Pp. xxiv+464. (London: Macmillan and Co., Ltd., 1914.) Price 17s. net.

In England, only one out of many so-called inter-Glacial deposits is considered to have stood the test of critical examination, viz., the shell-bearing clay of Kirmington, which is overlain and underlain by Boulder Clay. It indicates a recession of the ice-margin between the periods of deposition of the purple and Hessle Clays, when the sea stood at a higher level in the estuary of the Humber than it does at present. The sequence of the drifts, the oscillations of the ice, the westward shifting of the centres of glaciation, and the Glacial drainage as worked out by Mr. Lamplugh, Prof. Kendall and others is clearly set forth.

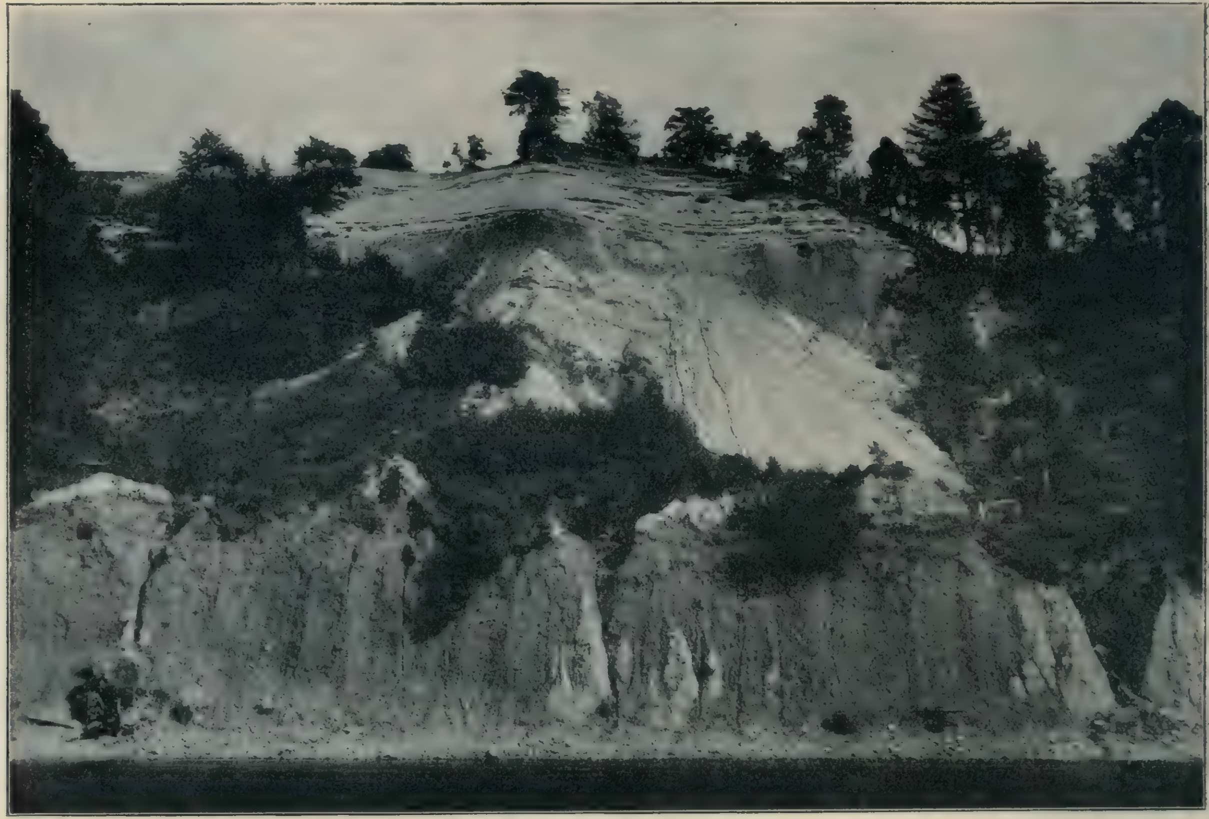

Photo.] [R. Lunn.
FIG. 2.—Section of glacial sand and gravel resting on Boulder Clay on the river Spey, opposite Rothes, Banffshire, Scotland. From "The Quaternary Ice Age."

The classification of the culture stages of Palæolithic man is based on that of G. de Mortillet, and of Neolithic man on that of Montelius. Special emphasis is laid on the great break between the Palæolithic and Neolithic industries of Europe. The transition phases (Campignien, Tardenoisien, and Asylien), which are supposed by archæologists to bridge this gap, fail to demonstrate a passage between the two.

One of the most interesting chapters in the volume is that dealing with the isostatic theory of the Quaternary oscillations of sea-level. This theory was first advanced by Dr. Jamieson to account for marine sediments of late Glacial age in Scotland. He believed that the earth's crust sank under the weight of ice and rose again when the ice disappeared. The author argues with much ingenuity that the late-Glacial and post-Glacial changes of level in Scandinavia may be accounted for by isostatic recovery from the effects of ice-load combined with a single oscillation of the sea-level.

This volume will be useful to students as a synopsis from a particular viewpoint of modern research in Quaternary geology. The illustrations deserve special mention. In selection and execution they are excellent. Two of them (Figs. 1 and 2) are here reproduced. JOHN HORNE.

WIRELESS TELEPHONY.

THE system of wireless telephony upon which Capt. Colin and Lieut. Jeance, of the French Navy, have been at work for some years has recently been considerably improved, and some very successful experiments were carried out last June, when, during some tests in which long-distance communication was established in France by means of an aerial only 164 ft. high, speech was incidentally overheard on a small amateur installation in Lincolnshire. The continuous waves used for transmission are produced by three arcs connected in series. Each has a negative electrode or carbon only 1·5 mm. diameter, and a copper disc negative electrode above it, which forms part of the bottom of a cylindrical tank filled with paraffin and cooled by water circulation. The carbon electrodes are beneath this disc, and their height is regulated by means of a crank outside the arc chamber. The arcs, which are very short, burn in an atmosphere produced by mixing acetylene and hydrogen generated from calcium carbide and calcium hydride respectively, and this not only prevents the burning away of the carbons, but actually increases their length slightly during operation.

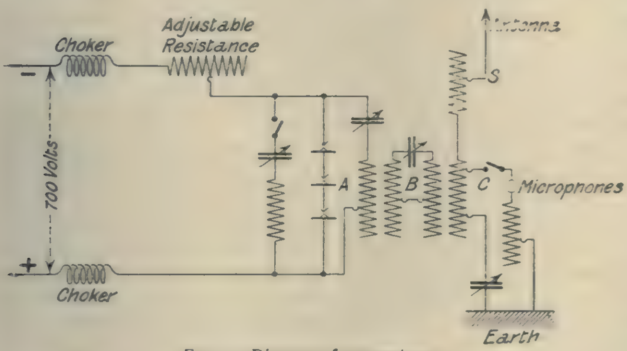

Fig. 1.—Diagram of connections.

A 750-volt dynamo supplies the three arcs in series, and there is means to regulate its pressure between 500 and 750 volts. Two choking coils (to prevent high-frequency currents from flowing back to the dynamo) and an adjustable resistance reduce the voltage at the terminals of the three arcs to between 250 and 350 volts. A current of from 3½ to 4½ amperes is employed.

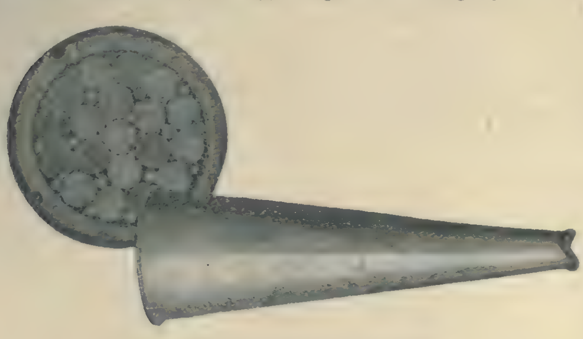

Fig. 2.—The microphone and megaphone.

The diagram (Fig. 1) shows the connections of the microphone and the oscillatory circuit. The principal oscillatory circuit consists of an inductance and variable condenser, connected in parallel with the arcs A. An intermediate oscillatory circuit B, consisting of an inductance and variable condenser, is utilised to couple the principal circuit with the aerial, and ensures that multiple waves generated in the main circuit are not transmitted to the aerial, the result being that only a single wave is emitted. The aerial circuit consists of an inductance coupled with the circuit B and a variable condenser. A variable self-induction is also used in the aerial.

In the microphone circuit are nineteen carbon microphones connected in series, and so arranged that they are all acted upon by the voice simultaneously by means of a megaphone. The microphone and megaphone (drawn to different scales) are seen in Fig. 2; the large end of the megaphone covers the microphone. The microphone cells are connected between the variable inductance of the oscillation transformer and earth, as shown at C. This has the double advantage of avoiding sparking, such as always occurs in the microphones when they are placed directly in the aerial circuit, and does not limit the energy which can be taken by them. The station has two complete microphone equipments, with a change-over switch, so that each can be used for a short time and the other microphone allowed to cool, as naturally very large currents are employed.

The transmitting coils consist of flat spirals of copper strip, and the condensers are of the glass-plate type. Arrangements are provided for very exact tuning by means of variable air condensers. The wave-length of transmission can be varied between wide limits; in the official tests a wave-length of 985 metres was used.

HIGH EXPLOSIVES IN WARFARE.

At the present time explosives are playing such a prominent part in the war that the interest and attention of the most peace-loving citizen are necessarily aroused by the terrible results undoubtedly produced, or are more morbidly affected by the tales of the alleged marvellous effects which are yet to be experienced. A few notes on the most important explosives being used in war may therefore be of special interest just now.

The explosives which can be advantageously employed in warfare are by no means the most powerful which the chemist can produce, or which may even be used in civil engineering or mining operations. The military high explosive must be sufficiently insensitive to shock to prevent its being exploded when struck by projectiles, or when submitted to the shock of being fired from a gun as the charge of shell, else it might prove as dangerous to the user as to the enemy. Thus the nitroglycerine class and many other explosives are excluded.

For many years gun-cotton, containing a considerable amount of moisture, was largely used for naval and military purposes. In the moist state it is extremely safe, but can be easily detonated when a small primer of dry gun-cotton is fired in contact with it. The explosive effect is great, and it provided an excellent and safe explosive for military mines and purposes of destruction, and as a charge for torpedoes. It was not, however, suited for use in shells.

The high explosives chiefly being used in the present war for shell-filling are picric acid, trinitrotoluol, and ammonal. Picric acid, with or without the admixture of various ingredients, has been in use at one time or another in most countries under the names of melinite, lyddite, shimose powder, etc. Until picric acid came into use, black gunpowder formed practically the only explosive used as a bursting charge for shells, and the use of picric acid was a great advance from the destructive point of view, as its explosive power was very much greater. Picric acid, although sufficiently insensitive to shock, has the property of readily attacking metals and forming picrates, which are much more sensitive and liable to explosion. This involves special precautions in dealing with it, and is an undoubted disadvantage.

Ammonal is a mixture consisting of ammonium nitrate, trinitrotoluol, charcoal, and aluminium in fine powder. It is very safe, and is more powerful than picric acid, but owing to the hygroscopic character of ammonium nitrate, its chief constituent, it has specially to be protected from moisture, which reduces and, if in sufficient quantity, destroys its power of explosion. It is largely used by the Austrians.

Trinitrotoluol is undoubtedly now the most widely used high explosive for military purposes under the names of "Trotyl," "Tritolo," "Tolite," "Tritol," "Trilite," and "T.N.T.," according to the nation using it.

"T.N.T.," as it is called in the British Service, has attained its position by virture of its merits. It is used in a state of great purity; it is chemically stable and without action on metals. It is unaffected by water, and can be fused and run into shells in the molten state. It is less sensitive to shock than picric acid. Hard blocks of suitable size and shape are covered by electro-plating them with a coating of copper, which prevents the blocks from being broken and having their edges chipped. In this form "T.N.T." is used for demolishing bridges, etc. Although not quite so powerful as picric acid, its other advantages make it at present perhaps the best available explosive for military use.

The destructive effect of an explosion is caused by the almost instantaneous conversion of the solid explosive into gases, at a very high temperature, with consequent sudden exertion of an enormous pressure. From the purely disruptive point of view, the composition of the gas produced is not necessarily of importance, the determining factors being the volume of gas, the heat produced, and the velocity of detonation. When however an explosion takes place in a confined space, then in addition to the disruptive or shattering damage, the components of the gas produced may have an injurious effect on anyone having to breathe it.

In the case of explosives for use in civil life, as in mining work, care is taken by adjusting the composition of the explosive that the gases produced shall not have a deleterious effect on the miner. In military operations this consideration does not arise; indeed, it may be maintained the more deadly the effect of the fumes the better.

Picric acid and "T.N.T." are definite chemical bodies, but owing to insufficiency of oxygen are not completely converted into gas on explosion, a considerable amount of carbon being set free. This accounts for the black smoke which is seen when these bodies are exploded.

In the earlier determinations, when explosives which contained insufficient oxygen for complete oxidation of the carbon and hydrogen were fired in a closed bomb, and the resulting gas analysed, it was found that its composition was affected by the density of loading. The higher the density of loading the higher the pressure, accompanied by increase of carbonic acid and decrease of carbonic oxide. Methane, which was absent or only in very small quantities at low densities of loading, increased steadily as the pressure increased. It was, however, recognised that the composition of the gas so found did not necessarily represent the composition at the moment of explosion, for the analysis was made some time after and when the gas had cooled. Consequently reactions had probably been taking place during the process of cooling. Finally, it was thought that the formation of methane was not a real result of explosion, but was due to secondary reactions during the cooling stage. The experimental difficulties of catching and fixing the gases at the moment of explosion were overcome by detonating the explosive in its own volume in a lead or porcelain bomb placed inside a larger evacuated steel bomb. The explosive had in this way to do work in bursting the smaller bomb, and the rapidity of cooling of the gas was thus so greatly increased that secondary reactions practically did not take place. When fired under these conditions, which correspond closely to those which exist when a shell explodes, the gases from ammonal, picric acid, and "T.N.T." were found to contain only small quantities of methane. In addition to carbonic acid, nitrogen, and hydrogen, ammonal contained about 24 per cent. and picric acid and "T.N.T." nearly 50 per cent. of the poisonous carbonic oxide. It is thus evident that where shells burst in confined spaces, in addition to the damage caused mechanically, those persons breathing the fumes may be fatally poisoned or seriously affected physiologically.

It has been suggested that the ingredients of shell charges may contain deadly poisons, but it seems improbable that any poison intentionally added to the contents of a shell would retain its toxic properties after the shock and heat of explosion. As seen above, the gases from the explosives now in use may be sufficiently poisonous under certain conditions.

The subject of explosives seems often to create a state of credulity, and to generate extravagance of statement on the part of the non-expert writer rarely effected by other matters. The unknown sometimes becomes truly appalling under his imaginative pen. Even inventors have been known to make wild statements in regard to their explosives! One should only accept with very many grains of salt the sensational statements which have appeared in some quarters as to the weird and deadly effects of recently-invented explosives. It is well, therefore, not to have exaggerated ideas of the power of explosives or to be unduly scared by the threat of explosives dropped from Zeppelins. The destructive effect of the large charges which can be fired from the huge howitzers used in the present war is terrible, but explosives have their limits.

While without doubt the damage done locally from the explosion of a large quantity of any explosive which might be dropped by a Zeppelin would be appalling enough, yet, judging from the effects of the accidental explosion of a couple of tons of nitroglycerine during manufacture, its area would be comparatively restricted, and the horrifying suggestions mooted of the coming total destruction of cities by explosives dropped from the sky may be ascribed to the imagination of the over-credulous. W. MACNAB.

PROF. INGRAM BYWATER.

ON December 18 there died in his house in Onslow Square the greatest Greek scholar of our time. Ingram Bywater was remarkable for the fact that he was imbued with the scientific spirit, and pursued the investigation of Greek thought—what may be called "the Greek thing"—in the true scientific method. He was in close sympathy with scientific men engaged in other branches of investigation, of the methods and results of which he had a remarkable understanding and appreciation.

Bywater was born in 1840, and after early days spent at University and King's College Schools, became a scholar of Queen's College, Oxford; then, in 1863, fellow and tutor of Exeter College. On the death of Jowett in 1893 he was appointed by Mr. Gladstone Regius Professor of Greek. It was chiefly through Bywater's influence that Exeter College was led to offer in 1872 a fellowship in the competition for which biology was to be the chief subject. Huxley and Rolleston acted as examiners on behalf of the College, and I had the good fortune to be the successful candidate. My college rooms were adjacent to Bywater's, and we became constant companions and friends. We often discussed—when the college slumbered—the life and learning of the world and our own special studies in a tobacco-parliament of two during the small hours of the night. I learnt more from him than I can say, and not only enjoyed his wise and humorous discourse and his freedom from pedantry, but formed a warm regard for his fine spirit, his wide learning, and his intellectual veracity. When my fellow-student Moseley—who had not competed for the Exeter fellowship owing to his appointment as naturalist on the *Challenger* expedition—returned from his travels, Bywater proposed that the college should elect him also to a fellowship, which was done.

In 1885 Bywater married the second daughter of Mr. C. J. Cornish, of Salcombe Regis, widow of Mr. Hans Sotheby, a former fellow of Exeter College. The work of her nephews, Charles and Vaughan Cornish, is well known to scientific naturalists. Bywater was singularly happy in his marriage, and after the death of his wife in 1908 never recovered his strength and vivacity. He resigned his professorship, but still gave his services to the University in connection with the Bodleian and the Press. He lived among his books in his London house, where after my own departure from Oxford in 1898 I was his neighbour and constantly with him as in the old days at Exeter College.

He had a most unfavourable opinion of the study of Greek as conducted under the examination and scholarship system at Oxford. "It is not Greek which they study," he said, "but an arbitrary and unreal creation of the examination system and the traditions of college tutors." He complained that when he was professor even those more serious students among the undergraduates who might have profited by his teaching were by college directors of study kept away from his class-room, as they were in earlier days held back from the lectures of Max Müller. Bywater published in 1880 a remarkable piece of research and discovery relating to the fragments of the Greek philosopher Heracleitus, which led to his election as corresponding member of the Royal Academy of Sciences of Berlin. He devoted many years to the criticism of the text of the "Ethics" and the "Poetics" of Aristotle, and in 1899 the Clarendon Press published his *magnum opus*, containing his recension of the text of the "Poetics" with an introduction, translation, and commentary. But the young college tutors had the power of directing their pupils "not to waste their time" with listening to this great and original investigator, and, instead, to work up their Greek in the examination classes of the colleges; and they exercised it! Such is the mischievous result of the English university dry-rot—the examination system.

Only a month ago when my friend had temporarily rallied from the illness which has now ended fatally, he discoursed to me in his characteristically cautious yet vigorous style of German (more especially Prussian) arrogance and intrigue and the boasted "Kultur" of the Germans. He said that the quality of their abundant work, never very high, had deteriorated since 1870, and contrasted their grasping and pretentious attitude at the International Conference of Academies in Vienna, where he represented the British Academy, with the charm and refinement of the leading Austrian delegate, Prof. Suess, the geologist, now also gone from us, who, he declared, justified his name by the sweetness of both his nature and his behaviour. E. RAY LANKESTER.

SCIENCE IN WARFARE.

WE reprint from the *Daily Mail* of December 18 a communication to that journal from a Belgian man of science showing how the Germans are utilising science for their operations in the newly conquered region in Belgium.

Here is a great lesson for us, for our Government cares too little for the nation's need for science, which is as important for peace as for war purposes.

Meteorology and the Scarborough Raid.

It is by no means surprising that for their raid on the three British coast towns the Germans should have profited so accurately by climatic conditions. When they first entered Belgium their army corps were immediately followed by the full staff of their observatories. On August 16 the astronomers and meteorologists attached to the Aix-la-Chapelle army corps took up their quarters at Liège, and on August 25 they were all at the Brussels Observatory at Uccle, where, on September 1, they were replaced by astronomers and meteorologists from Berlin.

Immediately on arriving at the Brussels Observatory the Germans turned out the Belgian staff. They made use of the Belgian instruments but supplemented them by the very up-to-date instruments they had brought from Berlin. On September 3 they began hunting for a Belgian hydrogen factory where they could obtain hydrogen for filling their testing balloons, by means of which they make their observations for predicting fogs. They used these balloons for forecasting the weather, particularly for the great German attack on Antwerp.

There is abundant evidence that the German men of science followed the same course with regard to the German raid on Scarborough, Hartlepool, and Whitby. They are admirably equipped for forecasting fog forty-eight hours ahead wherever they are. The German Army meteorological stations have certainly been transferred to Ostend and Zeebrugge. They may not be as important as submarines, but these observation stations can render almost as effective aid in Germany's work of destruction as these engines.

NOTES.

M. C. E. Guillaume, the director of the Bureau des Poids et Mesures at the Pavillon de Breteuil, Sèvres, has made it known that the Institute of France has started a hospital, using for the purpose the funds at its disposal, and the voluntary contributions of its members. In Great Britain there are about thirty Associés Etrangers and correspondants of the institute, who have been notified of the action of the institute, and they have responded generously to the appeal of their French colleagues.

We learn from *Science* of the death at sixty-four years of age of Dr. D. E. Salmon, chief of the U.S. Bureau of Animal Industry from 1884 to 1906.

We regret to announce the death, at seventy-one years of age, of Mr. A. R. Hunt, of Torquay, fellow of the Geological and Linnean Societies.

We regret to see the announcement of the death on November 10, at seventy-five years of age, of Prof. N. C. Dunér, secretary of the Swedish Royal Society of Science, Upsala, associate of the Royal Astronomical Society, and author of astronomical works of prime importance.

It is announced that, owing to continued ill-health, Dr. E. F. Bashford has resigned the post of general superintendent of the Imperial Cancer Research Fund, which he has held for the past eight years, and that his resignation has been accepted by the executive committee.

The Royal Geographical Society has arranged two lectures to young people for the new year. On January 4, Mr. C. Carus-Wilson will lecture on the earth's unstable crust; and on January 8 the Rev. T. T. Norgate will take as his subject the theatres of war, illustrated. The meetings will be held in the Kensington Town Hall, High Street, Kensington, at 3.30 p.m. Application for tickets should be made to the chief clerk, Royal Geographical Society, Kensington Gore, S.W.

At the fifth annual general meeting of the Society of Engineers (Incorporated), held on Monday, December 14, the awards of premiums made in respect of papers published in the journal of the society during 1914 were announced as follows:—The president's gold medal to Mr. A. S. E. Ackermann for his paper on the utilisation of solar energy; the Bessemer premium, value 5*l.* 5*s.*, to Mr. A. S. Buckle for his paper on cylinder bridge foundations in the East; the Clarke premium, value 5*l.* 5*s.*, to Mr. S. M. Dodington for his paper on mechanical appliances for the painless killing of animals; the premium, value 3*l.* 3*s.*, for members of affiliated societies, to Mr. R. H. Cunningham (Crystal Palace Engineering School) for his paper on irrigation in India; a society's premium, value 2*l.* 2*s.*, to Mr. James Tonge for his paper on uses of the hydraulic mining cartridge. Mr. Norman Scorgie was elected president of the society for 1915.

The Royal Institution has circulated an illustrated brochure which explains for popular purposes the nature and objects of the institution. The institution was established under a charter of George III. in 1800, and enlarged and confirmed by an Act of Parliament in 1810. The objects of the foundation are "to prosecute scientific and literary research; to illustrate and diffuse the principles of inductive and experimental science; to promote social intercourse among lovers of science, men and women; and to afford them opportunities for collective and individual study." It is not necessary to insist upon the value to the world of the scientific work accomplished in the laboratories of the Royal Institution, when the names of a few of the great men who have worked there are recalled: Davy, Faraday, Tyndall, to say nothing of living men of science. The hope may be expressed that there will be no diminution of the usefulness and popularity of the institution in view of the war, but that its influence may become increasingly powerful as the years pass.

A distinguished traveller and servant of the Empire has passed away in Archibald Ross Colquhoun, who died on December 18. He was born in 1848, and his earliest civil service was in the Indian police. From this he passed to the public works department, and then became secretary to a Government mission to Siam, and the Siamese Shan States. Later he was Deputy Commissioner of Upper Burma, but before this, in 1881–82, he made an important journey from Canton to Bhamo, investigating the possibilities for a Burma-Chinese railway route, and also acted as a special correspondent in the French war in Tongking (1883–84). Afterwards, having left Government service in the East, he came into contact with Cecil Rhodes, served with the South African pioneer force, and became administrator of Mashonaland in 1890. In later years he travelled extensively and wrote much on South Africa, on the Far East, on the Pacific and the Panama Canal schemes, and on other topics. Some of his books are important contributions to the study of great political questions, such as "The Key of the Pacific" (on the Panama Canal routes), "China in Transformation," "The Mastery of the Pacific," and "The Afrikander Land." He was closely associated with the work of the Royal Colonial Institute, and was editor of its journal, and among various honours he received the gold medal of the Royal Geographical Society.

The organised methods employed by Germany in commerce, and the means necessary to meet them successfully, were referred to by Sir William Ramsay in an article contributed by him to Nature of November 12 (p. 275). Sir William deals with the same subject in further detail in a paper just issued by the Institute of Industry and Commerce (Aldwych Site, Strand, W.C.) The German military organisation has its counterpart in their commercial organisation; there exists an Imperial Council the proceedings of which are kept quiet, but which takes into consideration all obtainable statistics, and so far as possible legislates, or endeavours to legislate, on the basis of these statistics. Where fiscal duties are found to be required, such a council puts them on; where there is an advantage in taking them off, they are removed. Where cheap transit is possible they give it; for the railways are the property of the State. In referring to these matters at the annual meeting of the Society of Chemical Industry in 1903, Sir William Ramsay said:—"Is it to be expected that any country can fight such a combination as that without adopting, at all events, something of their methods, or without studying their methods, and without combining together, if not to imitate them, at least to thwart them? There is a military campaign against us, and we must defend ourselves." Sir William points out that it will be necessary, if the future German State is allowed to retain the power of waging an industrial war, to combat it by the action of the organised British nation, that is, by the State. Once that conquest is achieved, we should do well to remember that commerce should be co-operative and not competitive; that it is to our interest not only that we ourselves should prosper, but that others should also prosper; that, indeed, our own prosperity is bound up in the prosperity of our fellow-creatures.

The Philadelphia meeting of the American Association for the Advancement of Science will open on Monday, December 28, when the retiring president, Prof. E. B. Wilson, of Columbia University, will introduce the president of the meeting, Dr. C. W. Eliot, of Harvard. Addresses of welcome by the provost and the governor-elect will be replied to by President Eliot, after which retiring President Wilson will deliver his address on "Some Aspects of Progress in Modern Zoology." There will be two public lectures, complimentary to the citizens of Philadelphia and vicinity, one on Tuesday night, at 8 o'clock, being by Dr. D. C. Miller, "The Science of Musical Sounds." On Wednesday night, at 8 o'clock, Dr. W. H. Nichols will lecture on "The War and the Chemical Industry." The titles of the addresses by the retiring presidents of the sections are as follows:—*Physics*: Recent evidence for the existence of the nucleus atom, A. D. Cole; *Botany*: The economic trend of botany, H. C. Cowles; *Anthropology and Psychology*: The function and test of definition and method in psychology, W. B. Pillsbury; *Mathematics and Astronomy*: The object of astronomical and mathematical research, F. Schlesinger; *Agriculture*: The place of research and of publicity in the forthcoming country life development, L. H. Bailey; *Education*: The American rural school, P. P. Claxton; *Engineering*: Safety Engineering, O. P. Hood; *Geology and Geography*: The relief of our Pacific coast, J. S. Diller; *Physiology and Experimental Medicine*: The classification of nervous reactions, T. Hough; *Social and Economic Science*: Social and economic value of industrial museums, J. G. Wall; *Zoology*: The research work of the Tortugas Laboratory of the Carnegie Institution of Washington, A. G. Mayer; *Chemistry*: Fermentation, C. S. Alsberg.

At a good old age—eighty-six—the famous Swiss guide, Melchior Anderegg, has passed to his rest. Born near Meiringen, at which place he died, he was bred and lived, except when undertaking some longer excursion, in the Oberland. He was introduced, if we remember rightly, to the Alpine fraternity by the late T. W. Hinchliff, who described, in his delightful "Summer Months among the Alps," excursions with him across the Strahlegg Pass in 1855 and up the Altels in the following year. Melchior's "great ascents" were rather more than twenty, for his employers, among whom we may number the Walkers, father, son, and daughter, A. W. Moore, H. B. George, F. Morsehead, C. E. Mathews, and Leslie Stephen, belonged to the old guard of Alpine climbers and did not consider the charms of an expedition enhanced by needless perils. The more notable of those ascents were Mont Blanc by the Aiguille and Dôme du Goûter, and by the more difficult route from the Brenva glacier; the Col de la Tour Noire, a most laborious pass, near the Aiguille d'Argentière, and the Roththal Sattel, one yet more dangerous, under the Jungfrau; the highest peak of the Grandes Jorasses, the Dent d'Hérens, the Parrot-Spitze of Monte Rosa and its culminating peak by a new route up the Grenz glacier, but probably there were very few of the more noted peaks and passes of the Alps with which Melchior was not acquainted. Besides this, he was an expert wood-carver, and small statues of friends from his chisel have more than once been exhibited in England. Melchior deservedly won the affection of all who had travelled in his company. He was one of nature's gentlemen, and the late C. E. Mathews, whose companion he had been for thirty-four years, truly says in his "Annals of Mont Blanc" that he was "perhaps the greatest all-round guide whom the love of mountaineering has ever produced. . . . It is with a peculiar pleasure and pride that I record that I never heard him utter a word to which the gentlest woman could object, and that I have never found him unequal to any kind of emergency."

IN the *American Museum Journal* for October-November Mr. G. G. MacCurdy, under the title of "Palæolithic Art as Represented in the Collections of the American Museum of Natural History," describes a number of objects acquired in France in 1912 by Prof. H. F. Osborn and the author. Among the most interesting specimens are a series of the tallies, or *marques de chasses,* which have been interpreted as records of their "kills" by the Aurignacian hunters; a set of perforated teeth, and shells of the Middle Aurignacian period from the Abri Blanchard, Dordogne; a holed limestone fragment, of which the utility is uncertain, it may have been used as a weight; figures of a horse engraved on stone of the Upper Aurignacian period from Roches-de-Sergeac, Dordogne, and of a reindeer on bone from Limeuil.

THE custom of cross-cousin marriage in South India, recently discussed by Dr. W. H. R. Rivers, is further considered by Mr. F. J. Richards in the December issue of *Man.* He arrives at the conclusion that it is based on economic considerations, and, in particular, on the mode of transmission of family property. The Dravidian people follow the rule of matrilinear succession. They subsequently came under the influence of the intrusive Brahmanical culture, in which the rule of patrilinear succession is followed. The effect of this clash of rival cultures was the desire of the matrilinear community to secure the advantages of patrilinear transmission of the estate; that is to say, the natural desire of the father to provide for his offspring might be secured by insisting that a man should marry the daughter of his maternal uncle, of his paternal aunt, or of his sister. This arrangement would enable a matrilinear community to conform to the patrilinear system of inheritance without fear of dissipating the family property, which is dependent on inheritance on matrilinear lines. The present practice of cross-cousin marriage is thus a compromise between the Dravidian rule of succession through the mother and the Brahmanical rule of succession through the father.

NEARLY the whole of part 6 of the tenth volume of Records of the Indian Museum is devoted to an account of fresh-water and terrestrial oligochætous worms, mainly collected in northern India, with descriptions of a number of new species. The author, Dr. J. Stephenson, of the Lahore College, remarks that the most noteworthy item is the occurrence of *Microscolex phosphoreus* (a widely spread species, the original home of which was probably in temperate South America), near Peshawar, at a distance of 700 miles from the sea. Although the dispersal from its original home across the Atlantic and Indian Oceans was doubtless due to the prevalent westerly winds, transport by human agency seems the only explanation of its isolated occurrence in the heart of northern India.

THE *Aarsberetning* of the Bergen Museum for 1913 and the first half of 1914 records steady progress in all departments during the period under review, a satisfactory incident being the bequest of 7000 kr. for general purposes. Numerous additions to the exhibited series of mammals and birds were made, but, judging from some of the figures in the text, there appears room for much improvement in the method of taxidermy. Ocean-surveying and the work of biological stations were carried on with great energy, reports from no fewer than forty-three stations being quoted. The contour of the channels of many of the Norwegian fjords is illustrated by a transverse section of the Sognefjord, in which the sudden descent of the sides and the great depth of the middle are well shown.

DR. W. SØRENSEN has published in French an important paper (*Kgl. Danske Videnskab. Selskabs Forhandlinger,* 1914, No. 3), on the anatomy of the Solifugida, that remarkable order of Arachnida which has attracted many zoologists to its study and which formed the subject of a lengthy memoir by the late H. M. Bernard (Trans. Linn. Soc. Zool., 2 ser., vol. vi.). The author criticises Bernard's work with some severity, pointing out that the latter's belief in the poisonous nature of the Solifugida is unsupported by facts, and that the structures designated by him as "coxal glands" have no openings on the haunches of the foremost legs, but terminate on short processes situated on the dorsal aspect of the appendages of the second pair. These appendages are termed "mandibules" by Sørensen. Considering the anterior position of the excretory organs under discussion, Sørensen's comparison of them with the Malpighian tubes of insects, which are outgrowths of the hind-gut, must remain open to question.

IN a recent issue of the Bulletin of the Imperial Botanic Garden of Petrograd (vol. xiii., No. 4), G. A. Nadson describes a number of interesting sulphur bacteria from brackish water in the Gulf of Finland. Two of the forms described are peculiar from the fact that the cells contain in addition to stored sulphur a substance which readily decomposes into oxalic acid; these bacteria live in badly aerated mud, and by increasing the oxygen supply the oxalite-like substance was found to increase, and the accumulation of sulphur to diminish, and *vice versa.* A remarkable new genus of sulphur bacteria, called Thiosphærella, was discovered, which contained in its cells large quantities of a starch-like substance; the other forms described are new species of the genera Achromatium and Thiophysa.

IN a paper which appeared in the *Annals of Botany* (vol. xxviii., No. cxii.) and of which we have received a reprint, Mr. S. R. Price describes some results obtained in the study of plant cells by the method of dark-ground illumination, a method hitherto but little used in botanical work. The method often reveals new structural features and is useful in establishing the presence of particles which are difficult to see or which are unresolved in direct illumination, but is very restricted in application on account of the difficulty of selecting suitable material for examination. Some of the author's observations indicate possible lines of work rather than completed results. For instance, it is generally recognised that protoplasm is a colloidal complex, apparently existing both in the hydrosol and hydrogel state, the two states being spontaneously reversible; the process of germination of fungus spores, followed by the dark-ground method, showed the gradual conversion of the gel contents of the spore into a hydrosol on absorption of water, and later a formation of a gel might occur again. The nucleus and chloroplasts are probably specialised parts of the plasma with a hydrogel structure, but only in favourable cases could the nucleus be studied. Particles and vesicular bodies (which the author terms "sap particles") were usually found in the cell-sap and showed a continuous Brownian movement; they usually increased in number with decreasing vitality of the cell.

THE problem of the dolomitisation of limestone has received an interesting contribution from Prof. R. C. Wallace, of the University of Manitoba (*Compte-rendu* of the twelfth International Geological Congress, 1914, p. 875). He regards the concentration of magnesium ions in the solution from which dolomite is precipitated as in many cases the determining factor. This concentration at moderate depths of sea-water may determine whether calcite or dolomite is stable; at a certain concentration of magnesium, calcite goes into solution and dolomite is deposited. In a solution in which calcite is stable, magnesium carbonate may be unstable, and may go into solution until the magnesium ions are sufficiently abundant to produce a precipitation of dolomite. In the case, again, of underground water bringing magnesium into a limestone, a solution may abruptly arise in which calcite is unstable and becomes replaced by dolomite. It will be seen that this view differs from the older one of the mere substitution of magnesium for part of the calcium present in a mass of calcium carbonate.

WE have received from Prof. Eredia a pamphlet entitled "The Organisation of the Service of Weather Predictions in Italy," reprinted from the *Rivista Meteorico-Agraria* (vol. xxxv., 50 pp.). An experimental system of weather telegrams was instituted in the Papal States from July to December, 1855, and the observations were forwarded to Padre Secchi for examination. His report of the experiment was favourable, but practically the commencement of the service dates from April, 1866, when observations were telegraphed to the central office at Florence. After the removal of the latter to Rome the service was frequently improved, under the direction of Prof. Tacchini, and the daily weather report has latterly again been considerably enlarged. The present director is Prof. L. Palazzo, whose name is well known to many of our readers by the interest he takes in geophysics generally. Prof. Eredia also gives a brief sketch of the origin of the weather service in Europe. With reference to this country he remarks that in 1860 the Astronomer Royal informed M. Le Verrier (Paris) of the proposed establishment of a service on our coasts, and requested an exchange of bulletins. This is strictly true, but it might be explained that the communication was in reply to an inquiry by M. Le Verrier, which would naturally have been referred to Admiral FitzRoy before being dealt with. The latter issued daily weather reports to newspapers from September 3, 1860, and storm warnings from February 5, 1861. It may be worth while to direct attention to two apparent slips in the last paragraph but one on p. 7 of Prof. Eredia's laborious and useful compilation (with reference to a storm on December 1–2, 1863): Islanda should read Irlanda, and M. Davy is quoted as director of the English service.

IN a review of Dr. Hobson's "Squaring the Circle" in the Bulletin of the American Mathematical Society for November, Prof. R. C. Archibald directs attention to the early use of the symbol π by William Oughtred (1574–1660) in his "Clavis Mathematica" of 1631 and in his "Theorematum in Libris Archimedes de Spheara et Cylindro Declaratio" (Oxford, 1652). Oughtred employs the symbols $\delta:\pi$ to represent the ratio of the semidiameter to the semiperiphery of the circle, although he does not use the symbol π separately. He states specifically that $\pi R/\delta$ is the semiperiphery of a circle of radius R. Prof. Archibald further directs attention to references to squaring the circle in the Birds of Aristophanes (produced 414 B.C.), lines 1004–5, and in the last canto of Dante's "Paradiso" (canto 33, lines 133–5, in Cary's translation), and he points out that Longfellow, in his translation, gives "to square the circle" as the equivalent of the Italian "Misurar lo cerchio."

IN an article on "The Conic as a Space Element," in the Transactions of the American Mathematical Society, xv., 4, Mr. Roger A. Johnson develops a system of co-ordinates for the conic in three dimension space analogues to the line co-ordinates of Plücker, by treating the conic as a degenerate envelope. It is interesting to note that the problem of the conic in space has been studied for the last sixty years, and that in 1908 the Belgian Royal Academy announced the offer of a prize for a discussion of the subject. It may, however, be pointed out that the problem of the aeroplane in space is at the present time of a far more urgent character, and that the most pressing need is for pure mathematicians who find no difficulty in dealing with cumbersome formulæ as abstract as those which occur in connection with these harmless but unprofitable conics. Still, it is interesting to learn that the totality of conics of a T_4 that touch two fixed planes, the intersection of which does not meet the axis of the T_4, constitute a T_2 of the most general type.

OUR ASTRONOMICAL COLUMN.

THE APPROACHING MAXIMUM OF ο CETI.—According to prediction, ο Ceti or Mira will be at its maximum brightness on February 11 next, but it should be noted that both the star's period and brightness are not always the same at each return to its full brilliancy. As the star remains at its maximum brightness (2·0 mag.) for about fourteen days, it will be at a maximum on February 4 (approx.). At the present time it is a conspicuous ruddy object in a 4-in. telescope (mag. about 6·0), and its spectrum discloses the strikingly brilliant flutings and the bright hydrogen lines. The variable is best situated for observation in the earlier part of the evening, and the following is its position:—

R.A.		Dec.
2h. 15m. 3s.	...	−3° 21′

The Antwerp Astronomical Society.—In this column references have been taken from time to time from the *Gazette Astronomique*, which was a monthly bulletin of the Antwerp Astronomical Society. The last issue (No. 81) appeared in the beginning of September, when the investment of Antwerp had already commenced. A certain number of the members of this society have taken refuge in this country, and many of their British friends have suggested the idea of continuing the publication of this bulletin in London. Many of the latter have already made an effort to solve the financial part of the scheme, and it is due to their initiative that General J. Lerissen (president) and M. Felix de Roy (hon. sec.), on behalf of the society, have issued a circular asking others to contribute. If sufficient support is forthcoming it it proposed to issue the bulletin in both French and English. It will contain, besides notes of observations and of scientific articles, ephemeral notes, reviews of publications likely to interest amateurs, and place at their disposal the working data provided by professional astronomers. Those wishing to help may obtain further information from the hon. secretary at 29 Stamford Street, London, S.E.

Some Results of the Recent Eclipse Expeditions.—Last week reference was made to the results of the Spanish eclipse expedition to the Crimea during August last, and attention was directed to a red coronal radiation at λ 6373·87, which was discovered by M. Carrasco on his photographic plates. This radiation is a new addition to the spectrum of the corona, and, like some other coronal radiations, seems to vary in intensity with the state of solar activity at the time of eclipses. M. Iniguez, the director of the Madrid Observatory, has just forwarded an enlargement (paper) of the region, between $H\alpha$ and D_3, the original of which was taken 13 sec. after second contact, and exposed for 10 sec. This print shows in the first place the sharpness of the images of the arcs, and in the second the clear and prominent arc due to the new coronal radiation. The wave-length is given as 6373·87 ± 0·04 A. units. In the *Comptes rendus* (vol. clix., No. 23) for December 7 M. Deslandres presents a communication by MM. J. Bosler and H. G. Block with reference to the results of the Meudon eclipse expedition to Strömsund (Sweden). The note is restricted to the results of one part of their programme, namely, the spectrum of the corona. The continuous spectrum of the corona was perfectly regular, and indicated no signs of flutings or Fraunhofer lines, but only gradations due to the sensitiveness of the photographic plate. The well-known green radiation at λ 5303·7 was entirely absent. In the red part of the spectrum a brilliant and intense new radiation appeared. The wave-length is given as 6374·5 Å. units (to 0·2 A.U. nearly), and agrees well with that determined by the Spanish observers.

Geminid Meteoric Shower, 1914.—Mr. Denning writes:—"The weather greatly interfered with observations this year. The sky was, however, favourable on December 8, and a watch was kept at Bristol, but there were few Geminids. These exhibited a well-defined radiant at 106° + 31°. The following nights were cloudy and wet, but on December 12 the sky cleared for a few minutes about 10.35, and six Geminids were noticed. Later, through openings in the clouds, further meteors were recorded, all from the same shower. There were two very distinct radiants, viz., at 109° + 33° and 119° + 32°. They appeared to be about equally active. In 1885 and 1892 the same pair of radiants were very rich, and seemed to prove that the shower is a double one. From a comparison of all my observations of the chief system near α Geminorum I conclude the radiant is distinctly a moving one like the Perseids. It seems visible during three weeks from November 25 to December 16, with a maximum on about December 12. This year I believe the display to have been a very rich one on that date, giving nearly forty meteors an hour, and I await observations from places where atmospheric conditions were more favourable than at Bristol. My positions for the radiant are as follow near the maximum:—

Dec. 5	...	102° + 33°	Dec. 11	...	109° + 33°
6	...	104° + 33°	12	...	110° + 32°
7	...	105° + 33°	13	...	112° + 32°
8	...	106° + 33°	14	...	114° + 32°
9	...	107° + 33°	15	...	115° + 32°
10	...	108° + 33°	16	...	116° + 32°

"From my observations in 1885 there is strong evidence that the companion shower at about 119° + 32° also moves eastwards, but more data are required. Our weather is rarely suitable at this period of the year."

Kashmir as a Site for a Solar Observatory.—Bulletin No. 42 of the Kodaikanal Observatory contains a very interesting report by Mr. J. Evershed on the seeing condition as studied by him in the valley of Kashmir. It may be remembered that last year he reported very favourably about this valley for solar observations during the months of August and October, and, contrary to all previous experience in other localities, he noticed that the definition of the sun was found to be of the best quality throughout the day and on all days that observations were made, there being apparently no marked variations depending on the height of the sun above the horizon, nor upon the type of weather prevailing. In order to test the conditions in this locality during other months of the year, and to make more critical observations both photographic and visual with larger instruments, an expedition was sanctioned by Government in April of the present year, and this report sums up the results obtained during the months of May, June, and July. A scheme of operations was arranged so that comparisons at Kashmir could be made with the experiences at Kodaikanal. For a detailed account of the results the reader must be referred to Mr. Evershed's report, but the following brief statement of the main result is as follows:—Taking a scale of seeing as very bad definition 1, bad 2, fairly good 3, good 4, and so perfect that no tremors can be perceived in the 8-in. solar image projected on a screen attached to a portable instrument as 5, then it may be stated approximately that the mean seeing at Kodaikanal for the whole year would hardly reach 2, whilst that in Kashmir valley would probably exceed 3·9. The number of days when the seeing ranged between 4 and 5 would be very much larger in Kashmir than in Kodaikanal. The photographic work was found entirely to confirm the visual observation, and, as he states, "indicates the enormous possibilities of progress in the study of solar physics which an observing station in Kashmir Valley would present." As the chief factor in solar research is the quality of the "seeing," the importance of the above conclusion cannot be put aside.

COLLIERY EXPLOSIONS AND COAL-DUST.

UNDER the title of "Great Colliery Explosions and their Means of Prevention" (London: The *Colliery Guardian* Co., Ltd.), Dr. W. Galloway has collected into a small volume a number of papers contributed by him between the years 1872 and 1908 to various publications; these were so scattered that their logical sequence was not always easy to trace, and they gain greatly by being presented in their order and gathered within the covers of a small volume.

The first two papers deal with the connection between colliery explosions and the state of the barometer, and showed, what no one probably doubts to-day, that there is a greater danger of firedamp explosions with a falling barometer than under any other atmospheric conditions. The next paper gives an account of a series of experiments which demonstrated that a violent atmospheric concussion, such as that produced by a shot, can force flame through the gauze of a safety-lamp, so that a lamp, which would be quite safe in a quiescent explosive atmosphere, may initiate an explosion if the same atmosphere is violently disturbed. This fact, like those above referred to, is a matter of such common knowledge to-day amongst miners that they are apt to forget that there ever was a time when it was not known, and it is as well that they should have at hand a reminder as to who it was that first discovered this very important fact.

The remaining papers are perhaps of higher interest than those already mentioned, as they all deal with the part that coal-dust plays in propagating colliery explosions. For a long time the coal-dust danger was either neglected or flatly denied even by the highest mining authorities, and Dr. Galloway deserves the greatest credit for the part he has played in forcing its recognition upon the mining community. It is evident from a perusal of the papers here collected that it was only gradually that the gravity of the danger of coal-dust explosions impressed itself upon Dr. Galloway himself, and that it was quite a long time before he could convince himself that coal-dust was dangerous in the entire absence of fire-damp. Thus in 1876 he disagrees with the opinions expressed by a French engineer, M. Vital, who held that finely divided coal-dust may of itself alone (*i.e.* without fire-damp) give rise to disasters, and he states his definite conclusion that "*a mixture of air and coal-dust is not inflammable at ordinary pressure and temperature*" (p. 57), and goes on to show that when as little as 0·892 per cent. by volume of fire-damp is added the mixture becomes inflammable. Already at this date, however, Dr. Galloway advocated the watering of the roadways in collieries so as to keep down the dust. In 1879 Dr. Galloway had apparently modified his views to some extent, for he then wrote: "It is probable, moreover, that some kinds of coal-dust require less fire-damp than others to render their mixture with air inflammable; and it is conceivable that still other kinds may form inflammable mixtures with pure air" (p. 73). In his first paper in 1882 he still seems to consider the presence of a minute proportion of fire-damp, too small to be detected by a safety-lamp in the ordinary way, which he calls the "*latent*" fire-damp, indispensable to the formation of a dust explosion, but he continued to experiment, and in his second 1882 paper he wrote that his experiments "show conclusively, I think, that fire-damp is altogether unnecessary, when the scale on which the experiments are made is large enough" (p. 111). It is important to note that Dr. Galloway reached this conclusion after six years of continuous experiments, in direct contradiction to his earlier views on the subject, and this fact should of itself have inspired confidence in the matured opinions that he expressed.

The remaining papers in this volume are devoted to an elaboration of this coal-dust theory, but though of undoubted importance, they are less so than the above-quoted series in which Dr. Galloway showed by direct experiment that coal-dust and air form an explosive mixture even in the absence of inflammable gas, and the fact that he was the first to furnish experimental proof of this has established his reputation as an original, accurate and painstaking investigator of colliery explosions; this little volume shows clearly enough the extent to which he has laid the coal-mining community not only of this but of all other countries under a deep debt of gratitude.

H. L.

THE EDUCATION IN LONDON OF REFUGEES FROM FOREIGN UNIVERSITIES.

A FEW weeks ago (NATURE, November 26) we gave an account of what is being done to establish an informal Belgian university at Cambridge, for students of the University of Louvain and other universities affected by existing military operations. Both the Universities of Oxford and Cambridge have, so far as we understand, offered a generous hospitality on a large scale to both the staff and students of Belgium universities, but while affording them every facility for quiet study, have not attempted to bring them systematically within their own system. The University of London, on the other hand, is putting at the service of refugee students not merely the teaching facilities of its two incorporated colleges, but also the right to enter its degree courses and to obtain its degrees on exceptionally favourable terms. It is allowing a partial or total remission of fees both for full teaching courses in expensive laboratory subjects, such as engineering and preliminary and intermediate medicine, and for entrance to examinations. It has further made special concessions as to both the matriculation and intermediate examinations, which will make it possible for the students to answer questions in French, and have their knowledge tested on the lines of education they have previously received in their own universities. If the Privy Council approve of the Amendment of Statutes which the Senate of the University is referring to them, a clever student who has come over to London from Belgian or French universities this autumn, will be able to pass the examinations in lieu of matriculation and intermediate by the early spring, and enter at once on his final course.

This interesting experiment to enable deserving students of the allied nations to obtain actual English degrees entails extraordinarily severe work on the administrative and teaching staff of the colleges. King's College has seventy-four of such students, University College sixty-seven, and the Imperial College a certain number. None of them knew English to start with, and special classes have had to be arranged to teach it them. The courses in foreign universities differ greatly from those of English universities, as well as from each other, and infinite care has had to be taken to discover the exact stage in each subject which a given student has reached. In engineering, for instance, in which King's College alone has forty-two such students, the standard of applied mathematics is much lower in the earlier stages in Belgium than in England, while that in pure mathematics is higher. Even allowing for the assistance of the Belgian professors who are being called into council, it is not above the mark to say that the time taken over each refugee student is as much as that over ten English students. Apart from the academic work, the hospitality which the senior common rooms of University and King's Colleges have extended to these students, many of whom are for the present quite without funds, cannot be left out of account. In regard to the Jewish students, who form a large proportion of the whole, and who are mostly Russian subjects studying at Liège or Ghent, valuable help has been received from the Central Jewish Committee.

This effort, however great the tax it imposes on the colleges, is worth making. It will enable Belgians who are medically unfit to go on active service, and Russians whose military service begins at the end of their university career, to obtain their professional qualifications during the war, and thus fill the depleted ranks of doctors and engineers in their respective countries. It will also spread a knowledge of English university education on the Continent, and not improbably make the University of London an international, as it is already an Imperial, centre of university education.

THE PRODUCTION AT WILL OF EITHER FUNGUS-GERMS, FLAGELLATE MONADS, OR AMŒBÆ FROM THE ULTIMATE SEGMENTS OF SMALL MASSES OF ZOOGLŒA.

AN illustrated article dealing with this question of the heterogenetic origin from small Zooglœa masses of Fungus-germs, Monads, or Amœbæ, written by me, appeared in NATURE of November 24, 1904. That article was prepared at short notice in consequence of a short letter on "Archebiosis and Heterogenesis," which appeared a fortnight previously, and at a time when I was not specially working at this subject. Of late I have been doing much work in this direction, and have made out many very important new points, and can now speak with more precision concerning the changes generally, and the modes of obtaining them.

My results were received with great scepticism, and no bacteriologist has been induced to attempt either to confirm or refute them. The possibility of "infection" has so dominated them, that they have refused to consider the question. Of late, however, three bacteriologists have accepted my request that they should allow me to demonstrate to them my position by their examination of actual specimens. This they did, separately, and as a result neither of them was able to doubt that the Fungus-germs, the Monads, and the Amœbæ were, in truth, derived from the ultimate segments of the Zooglœal masses; nor did they suggest that the very similar developmental changes to be seen in hundreds of Zooglœal masses taken from their respective scums could possibly be accounted for by "infection."

Only one of my friends had any interpretation to suggest in opposition to my own. He started the supposition that what appeared to be bacterial aggregates might "possibly," in spite of their appearance, not actually be of that nature. He suggested that, though taking the guise of bacteria, and though all were similar in appearance, they might nevertheless be some hitherto unknown progenitors of Fungus-germs, of Monads, and of Amœbæ which had aggregated as Zooglœal masses, and subsequently given rise to their respective products.

This wild supposition may, at all events, be taken as an indication that its author could not doubt the fact of the different products coming from the ultimate segments, or imagine that "infection" could account for what he had seen. It was started by one who was absolutely opposed to the very notion of heterogenesis. He was subsequently able to find absolutely no support for his "possibilities," and after a futile search frankly admitted that only bacterial Zooglœas were known, apart possibly from others of an algoid type.

The current notion among bacteriologists concerning the nature and mode of origin of Zooglœas is that adopted by R. Muir in the article, "Bacteriology," in the last edition of the "Encyclopædia Britannica" (vol. iii., p. 161), in which he says:—"The Zooglœa is now known to be a sort of resting condition of the Schizomycetes, the various elements being glued together, as it were, by their enormously swollen and diffluent cell-walls becoming contiguous."

But bacteriologists do not seem ever to have examined the small masses that form in the scum on the surface of a hay infusion. I have been unable to find any reference to them, or of processes of segmentation occurring in any other Zooglœas. I cannot think that those with which we are now concerned are formed in the manner above indicated. All the evidence seems rather to show that as the bacteria rapidly multiply they also excrete the jelly-like glœal material in which they are subsequently found to be imbedded.

Preparation of the Infusions.

One of the important new points recently ascertained is that I can prepare two small infusions at the same time from the same sample of hay, and by allowing one to infuse for three hours at a temperature of 90° F., can feel confident that in the course of three to five days the ultimate products of segmentation of the Zooglœas that form can be made to yield Monads or Amœbæ; while if the other is infused for the same time at 98° F. no Monads or Amœbæ will appear, and the ultimate Zooglœal segments, though formed, and very similar in appearance, will remain apparently stationary for eight to thirteen days, and then begin to show themselves as multitudes of brown Fungus-germs.

It is best to use comparatively new hay, and not that of the previous season. I take a small portion and having cut it into ½-in. lengths, place it in 2-oz. beakers to which water is added just sufficient to cover it. The proportion of the two I have found to be a little more than 30 grains to the ounce of water. As soon as the infusions have been made they are filtered through No. 0 Swedish paper (so as to exclude encysted Kolpodæ and the great majority of Fungus spores) into common one-ounce porcelain pots, until they are about half-full—the depth of the infusion being then only a little more than half an inch. The scum which ultimately forms will be thin, and therefore much more favourable for examination than if it had been thick and formed over a greater depth of infusion. The covers are replaced on the pots, and the dates and temperatures at which the infusions have been made are marked thereon. These covered pots are then mostly kept at room temperature, 62°–64° F.

Examination of the Scum or Pellicle.

The pots are not usually opened until two days have elapsed, as it would be only during the last twelve hours that any very distinct scum begins to form, and that a few very small Zooglœas may be found scattered through it. By the end of the third day the Zooglœas may be very numerous, and will be found to vary much in size and shape. An example illustrating a rather later stage is shown in Fig. 1, in which the little masses are seen to be extremely numerous. Many of these early Zooglœas already show primary processes of segmentation.

In order to examine the scum a small portion is taken up on the point of a scalpel and rotated off on to a drop of distilled water. If thereafter it should be desired to preserve the specimen some 5 per cent.

formalin is run in, and the cover glass is ringed. But where there are brown Fungus-germs it is better to let the specimen remain in water, as the formalin, and also glycerin, would speedily remove their characteristic colour.

When some of these first-formed small Zoogl&oelig;as are examined with a high power, it becomes obvious that they are simple aggregates of bacteria, such as may be seen in Figs. 2, A, and 3. Further, just the same kind of bacteria are to be seen within them as in the scum immediately around; and the bacteria from the scum of the infusion prepared at 90° F. do not differ morphologically from those of the scum on the infusion prepared at 98° F.

It must come to be a question whether the different products ultimately yielded by the two sets of Zoogl&oelig;as can in part be attributed (*a*) to the fact that the constituent bacteria are actually different in the two cases, or (*b*) to the fact that the slightly different (and far from lethal) temperatures at which the two infusions have been prepared, have sufficed to modify the physiological attributes of the same set of bacteria. The latter seems to me to be by far the more probable explanation, looking in part to the seeming morphological identity, and also to the possibility that the exposure to the higher temperature of 98° F. for three hours may have somewhat degraded the molecular structure of the bacteria, so that these particular aggregates are only eventually capable of yielding vegetal rather than animal products, and that, too, after rather more than twice as long a period. Important facts in support of this conclusion will be reported later on.

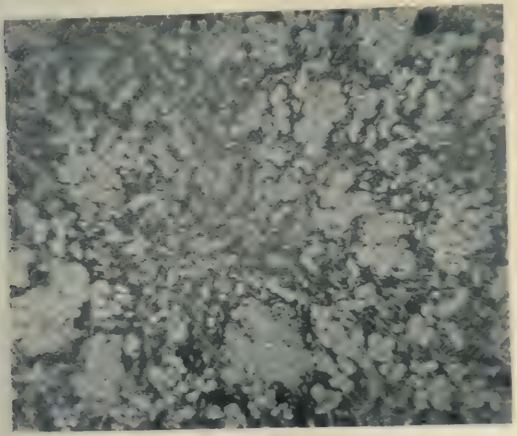

FIG. 1.—× 200.

It is, moreover, a very remarkable circumstance that almost until the ultimate products of segmentation are reached there seems to be no means of distinguishing by mere microscopical examination whether the Zoogl&oelig;al masses are going to yield brown Fungus-germs, Monads, or Amœbæ. As they grow and develop, they all tend to segment into smaller and smaller portions; and after a time the constituent bacteria become hidden owing to molecular changes in the glœal material. These are also shown by the segments becoming glistening and more refractive, and at the same time more receptive of logwood and other stains.

Conversion of Ultimate Segments of Zoogloeas into Brown Fungus-Germs.

In Figs. 2–5 are to be seen portions of some of the Zoogl&oelig;as from pots containing an infusion that had been prepared at 98° F., and the scum on which subsequently yielded only Fungus-germs.

Fig. 2, A, shows a portion of one of the Zoogl&oelig;as at an early stage, in which the bacteria are still very distinct, though later they often tend to become more or less enlarged and altered in appearance. In Fig. 2, B, a later stage is shown in which much segmentation has taken place, where the bacteria are no longer recognisable, and the segments have assumed the glistening appearance already referred to

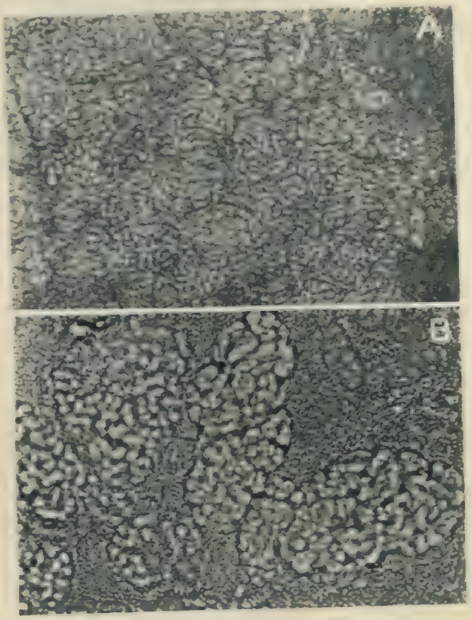

FIG. 2.—× 500.

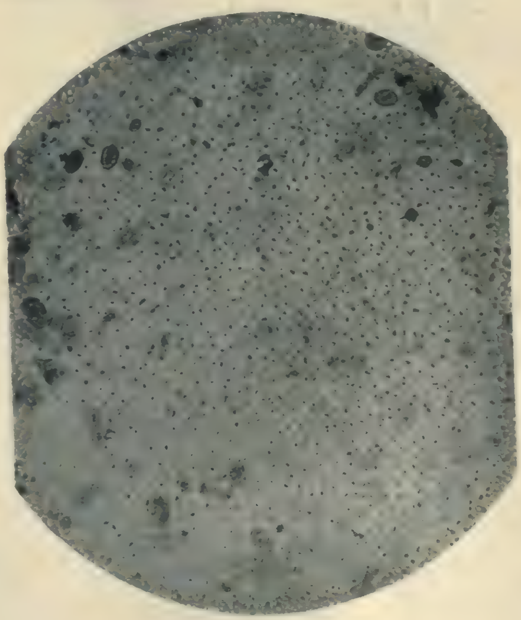

FIG. 3.—× 500.

The date at which the change into brown Fungus-germs begins is subject to considerable variation, but this colour is rarely seen before the eighth or after the thirteenth day—the time needed being in part dependent upon the temperatures at which the pots are kept.[1]

The actual mode of production of the Fungus-germs from the bacterial aggregates may be seen in Figs. 3–5. A portion of a Zooglœa lightly stained with *C. fuchsine* is shown in Fig. 3, in which the bacteria are remarkably distinct, and where here and there they are becoming enclosed within distinct cell-walls. We see, in fact, a free cell-formation going on, in which the bacteria become the nuclei, and these nuclei undergoing division. Fig. 4 shows other stained specimens illustrating the mode in which segmentation progresses from multibacterial aggregates in A to multinuclear masses in B, which lead on in C to separate ultimate products in the form of nucleated Fungus-germs.

In Fig. 5 we have to do with unstained specimens gradually assuming a brown colour. In A the three pale masses show early stages in which the Fungus-germs are forming, *in situ*, in fairly large segments; while the dark masses around are aggregates of brown, fully formed Fungus-germs. In B we have a more ill-defined Zooglœa, in which careful examination will reveal portions becoming more and more distinct, until they end with groups of large well-defined brown Fungus-germs.

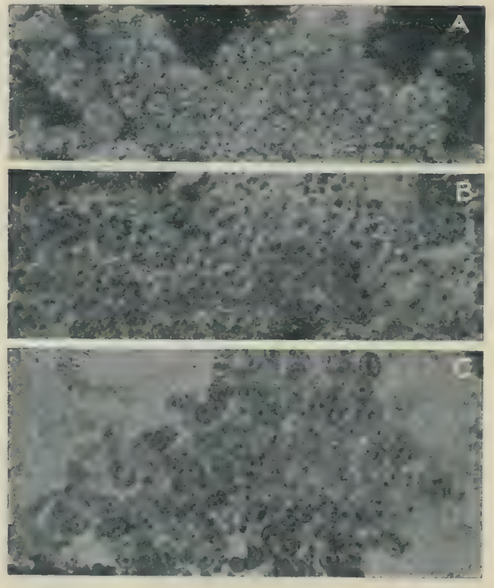

Fig. 4.—×500.

We have here then a direct free formation of cells, the existence of which has so long been doubted, where bacteria constitute the nuclei, and the altered glœal material the remaining portions of the cell-protoplasm. What is so plainly to be made out in Figs. 3 and 4 seems generally to occur when Fungus-germs are formed in and from Zooglœas; and the mode in which segmentation is so clearly shown to progress in Fig. 4 probably holds good for all other Zooglœas, even when the ultimate products are of a wholly different order

In all cases the Fungus-germs produced in the manner I have shown, though they multiply to some extent so as to form small heaps or short chains, remain as such for very many days, and require to be much coaxed in order to undergo further development with production of hyphæ.

Conversion of Ultimate Segments of Zooglœas into Flagellate Monads.

Where the infusion has been prepared for three hours at 90° instead of at 98° F. the Zooglœas which form present no difference in appearance and in mode of segmentation from what has been represented in Fig. 2.

There is, however, this remarkable difference, that such masses never assume a brown colour, and their ultimate products of segmentation begin to be visibly transformed in three or four rather than in from eight to thirteen days, and then they reveal themselves as rapidly increasing swarms of flagellate Monads.

These ultimate segments appear at first as little spherical, motionless bodies, such as are shown dispersed at the edge of a portion of scum in Fig. 6, A, and also aggregated as ultimate products of a small mass in 6, B, though they are there somewhat obscured by a few overlying bacteria. A smaller aggregate of motionless units is represented above, while below, before the running in of some formalin solution, some of the bodies shown were active Monads.

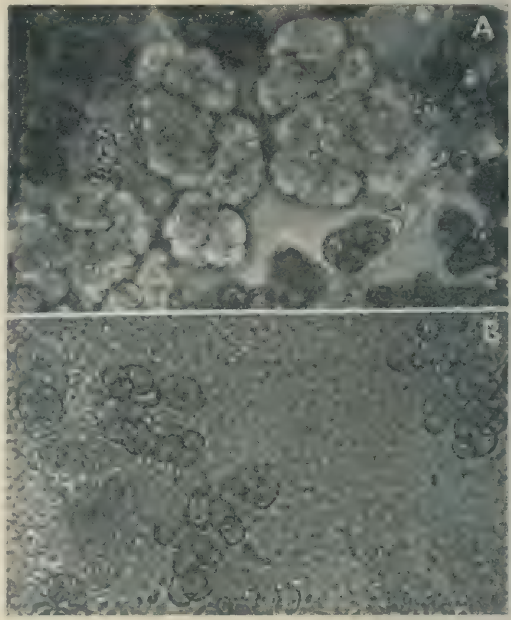

Fig. 5.—×700.

These Monads always contain a few granules, such as are shown in 6, C, in the lower body on the right, and a quite small nucleus is also frequently recognisable in such early units. Slight variations in size and shape of the Monads are met with from different samples of hay, just as different kinds of Fungus-germs are also produced. They have generally two flagella, though one of those that I succeeded in photographing (Fig. 6, C) has three. I have never previously been able to get any tolerable photograph of these Monads; this time I was to some extent successful with the aid of eosin. All other dyes or preservatives have proved useless, owing to the extremely delicate structure of the Monads. At times when a slide has been under examination for a rather long time, some of the Monads have become quiescent, and then I have often been able to recognise a contracting vacuole near the posterior extremity, rhythmically opening, and sharply closing about every twenty seconds.

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[1] Where the infusion has been made at a higher temperature, such as 100°–102° F., the appearance of the brown Fungus-germs may be still further delayed. What I have to say in this communication refers only to the products from the Zooglœas that may be found within the first fourteen days.

Flagella, nuclei, and contracting vacuoles appearing in animal units independently of heredity, and as derivatives from chance bacterial aggregates, such facts now revealed supply us with marvels far surpassing what was previously seen in the way of origin of nuclei and free-cell formation during the genesis of brown Fungus-germs—though even these latter changes give the death-blow to Virchow's celebrated dictum, *omnis cellula e cellula*.

Conversion of Ultimate Segments of Zoogloeas into Amoebae.

This is perhaps a more interesting and remarkable transformation than either of the other two. When I last wrote on this subject I was altogether unaware of the nature of the differential conditions favouring the conversion into Amœbæ rather than into Monads. Now I have found that this production of Amœbæ can almost always be brought about by preparing the infusion at a temperature of 85°, rather than at 90° F., and by subsequently keeping the pots at a temperature rather higher than that generally adopted. Sometimes, however, in such trials both Monads and Amœbæ are produced simultaneously.

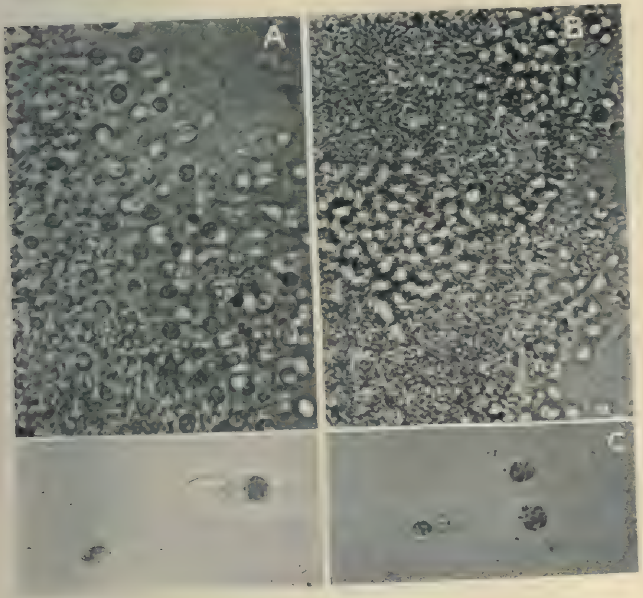

FIG. 6.—A and B × 500; C × 700.

The procedure mentioned generally leads to the production of a very large number of Zooglœas, which have essentially the same bacterial constitution and mode of segmentation as have been met with in the other Zooglœas, and which are represented in Fig. 2.

The transformed ultimate products of segmentation begin, as in the last case, to show themselves on or about the third day, while by the fourth and fifth days actual myriads of minute Amœbæ are to be seen in every portion of the scum taken up for examination, so that at last no traces of the very numerous Zooglœas from which they have been derived are to be found. These Amœbæ often at first have a single flagellum.

One of the final stages in such a resolution is shown in Fig 7, A, where the ultimate units, which are mixed with a few actual Amœbæ, are still pretty closely aggregated. In a few of them quite small nuclei are shown, though these are much smaller than what are generally to be seen in embryo Fungus-germs just separated from a parent mass. The latter are also usually more ovoid, and have much more well-defined outlines.

A few of the myriads of Amœbæ as they appear in the formalin solution are represented in 7, B. The great crowds of Amœbæ produced soon lead to conditions unfavourable for their existence, so that after another two days they will generally be found to have become encysted, as represented in Fig. 7, C.

Whether altered bacteria again furnish the nuclei of the finished products cannot be positively stated. The nuclei are always rather large in embryo Amœbæ, and distinctly larger than in young Monads.

A point of great importance in reference to what I have said concerning the comparatively sudden appearance of great swarms of small Amœbæ is the fact that such organisms can only rarely be seen to undergo division when immersed in fluids. I have long expressed this view, and now find it supported by the latest workers on these organisms, namely, J. W. Cropper and A. H. Drew, in their recently published "Researches into Induced Cell-Reproduction in Amœbæ." The rapid appearance, therefore, shown to occur of myriads of minute Amœbæ would be quite inexplicable by ordinary processes.

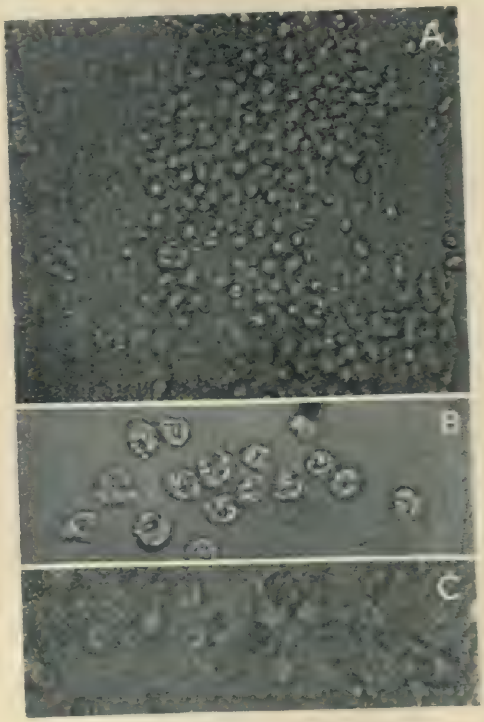

FIG. 7.—× 500.

In what has been said details have been given which will almost certainly lead, at will, to the production either of Fungus-germs, of Monads, or of Amœbæ. I have already expressed the opinion (p. 462) that we have not necessarily to do with different bacteria in these cases, but rather with the same bacteria differently modified by the prolonged, though comparatively slight, differences of temperature maintained during the production of the infusions.

The recent access of cold weather has enabled me to confirm this, and has, moreover, shown that the temperature at which the pots are kept is only a little less important than the variations in temperature at which the infusions are prepared. I have found, for instance, that infusions prepared at 90° and 85° F. respectively, will no longer yield Monads or Amœbæ if the pots are from the first kept at a temperature of 50°–54° F. Then, in each case, as a rule, only brown Fungus-germs begin to appear after eight or more days, instead of the Monads or Amœbæ which would have appeared had the pots been kept at the higher temperatures previously indicated.

Here then we have the revelation of still more astounding facts, since it seems to be shown that Amœbæ, Monads, and Fungus-germs are actually interchangeable products, capable of being derived from similar bacterial aggregates, under the influence of slight but well-defined differences of temperature.

A Few New Details Concerning Some Tube Experiments.

In a previous communication to NATURE for January 22 of this year I gave some account of my experiments with saline solutions in sterilised tubes, tending to show that living matter is still appearing *de novo* on the surface of the earth, seeing that under the very restrictive conditions necessitated by these experiments there was abundant evidence to show that Bacteria, Torulæ, and simple Moulds have repeatedly come into existence.

I stated that my experiments had been repeated in Paris with positive results by Albert and Alexandre Mary. They not only obtained organisms from their tubes, but caused them to multiply in different culture media.[2] My experiments were also repeated in New York by Drs. Jonathan Wright and MacNeal. After some negative and some doubtful results, they succeeded last year, among a few other successes, in producing crowds of organisms in every one of a set of twelve tubes, containing colloidal silica and other materials which I had sent them. At first they felt strongly of opinion that the results obtained from the first of these tubes, in which, as they said, unquestionable organisms were found in "enormous numbers," must have been due to the pre-existence of organisms in the materials used. But after careful examination of the materials they found no support for this supposition, admitted that they could not take refuge in any other, and added, "we have no suggestion to make other than your interpretation, and, indeed, we desire to be entirely non-committal as yet."

These experiments were undertaken by Dr. Wright, as he told me in his first letter asking to be supplied with some of the actual materials used by me, in consequence of his "sincere desire to ascertain the truth"; but only a few weeks after they had found unmistakable confirmation of my results, I received a letter informing me that he and his colleague were not intending to pursue the investigation. One reason alleged for their relinquishment of the investigation at this particular juncture was their non-success, in the few, and only slightly varied, attempts made to cause the organisms to grow in culture media.

Dr. Wright has, however, been good enough to send me some of their notes and unopened tubes, and amongst them I have received and opened three of the twelve tubes in question. On examination the organisms contained in each of them have been similar to those found in the first tube, specimens of which had been sent to me. In others, opened in New York, I am told the organisms have also been similar.

In Fig. 8, A and B, two of the many larger organisms found by me are shown. They are of a kind new to me, not corresponding quite either with *Streptothrix* or *Crenothrix* to which they seem most allied. In Fig. 9, A, one of the numerous early forms of such an organism, is shown; while in Fig. 9, B, we have a highly magnified reproduction of one of the many small masses which were found, similar to one which is to be seen in Fig. 8, A. In this mass, among crowds of bacilli, there seem to be also many embryonic forms of the large organism.

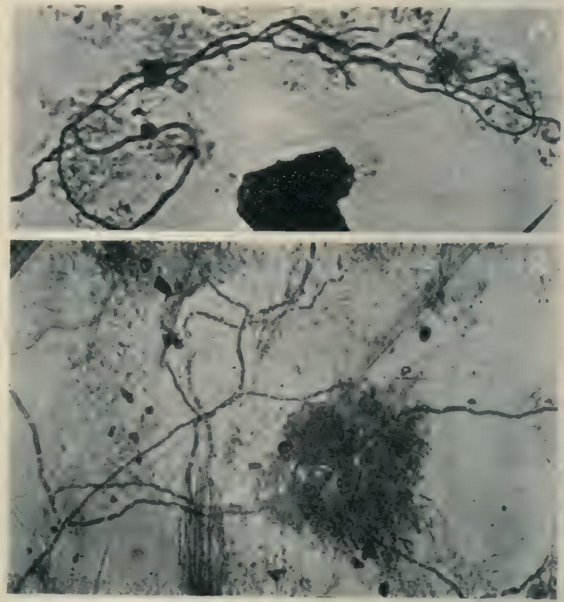

FIG. 8.—×350.

I handed the last of these tubes to Aubrey H. Drew,[3] as he kindly undertook to try to develop the organisms. He has been successful, with the aid of tyrosin and other auxetics, in cultivating the bacilli, more or less freely, in six different media, but not the large organism. The bacillus, too, seems to be strange; he has tested it in various ways and its

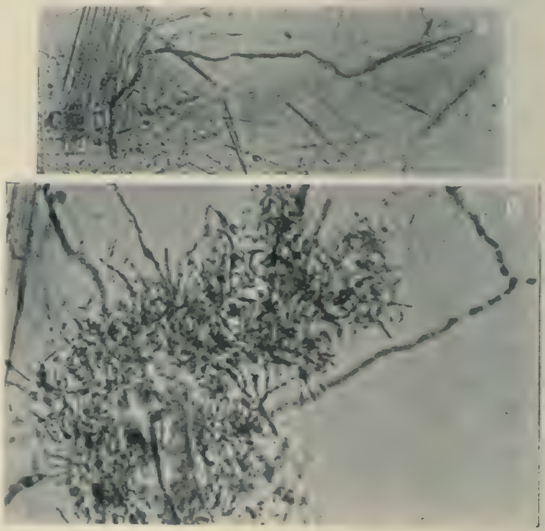

FIG. 9.—A×530; B×700.

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[2] See *Le Medecin* (Brussels), October 31, 1913, and January 15, 1914.

[3] Joint-author with Dr. J. W. Cropper of "Researches into Induced Cell-Reproduction." (Murray, 1914.)

behaviour, he tells me, is not in accord with any known form. He says: "It is large, 10 to 15 μ long, and shows a strong tendency in fluid cultures to grow into filaments, but I have not observed any branching." It is gram-positive, stains with difficulty, and "its most characteristic feature is a brilliant lemon yellow growth on auxietic agar."

I should like to refer to one other recent experience. In June 26–28, 1912, I prepared and sterilised six tubes containing a yellow solution composed of 3 drops of sodium silicate and 8 drops of liquor ferri pernetratis to the ounce of water. Five of these tubes were opened and their contents examined after periods ranging from six to nine months, and in each embryo Torulæ and other torula-like bodies, together with a few very minute mycelia of indeterminate types, are recorded by my notes to have been found. The sixth tube (No. 416) had been most of the time in the incubator, and was not opened till August 2 of this year—that is, more than two years after its preparation. Some previous experiences induced me to make such a trial. On opening the tube, in which there was only a very small amount of deposit, I obtained the whole of it in two dips with a pipette (the centrifuge used afterwards showed only a few shreds, granules, and minute glass splinters). The contents of the dips revealed many of the same torula-like bodies as had been found in the other tubes, and also "four masses of minute mycelium issuing from aggregates of minute spherical and ovoidal germs, together with granular matter, in part seemingly composed of typical cocci and short bacilli." With the Moulds, as shown in Fig. 10, A and B, there were masses of spherical spores with a central dot in each, together with small heads of fructification of Penicillium type bearing similar acrospores.

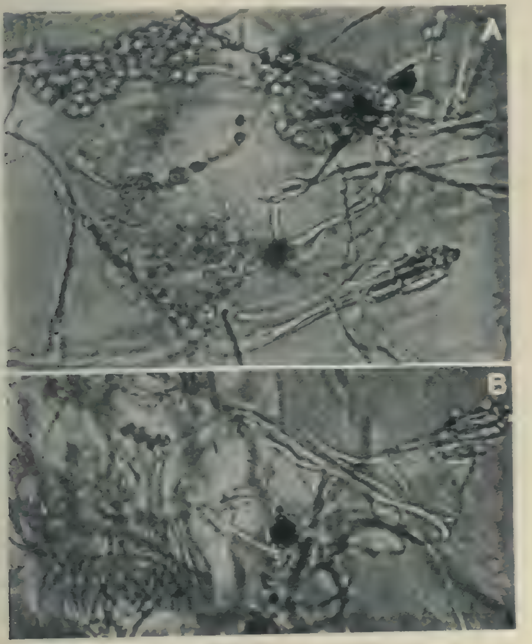

Fig. 10.—× 700.

From a very similar solution contained in four other tubes, prepared on May 17–19, 1912, in three, which were opened at periods varying from seven to ten months, the spores and mycelium of a mould of Oospora type were found by myself and others. The fourth tube was kept for nearly seventeen months before it was opened, and two months before that date two obvious tufts of mould could be seen at the bottom of the tube, one of them nearly half an inch in diameter. When this tube was opened in Prof. Hewlett's laboratory, we saw that the growth was again a mass of Oospora[4] with the same characteristic spores as had been previously found. All this set of tubes had been exposed to light during the first six months, while the others had been in the incubator.

Concluding Remarks.

Many critics of my tube experiments have been incredulous either as to the organisms found in the tubes being really organisms, or else as to their being living and actually engendered within them. They found it difficult to reconcile with ordinarily entertained notions the idea that organisms like bacteria and Torulæ, to say nothing of Moulds, could be products of so-called "spontaneous generation."

Let such critics spend two or three weeks only in examining the developmental changes in the Zooglœas formed in a hay scum, and see how much many other cherished preconceptions will be upset. Are they ever likely to do it? Well, let them bear in mind that three bacteriologists to whom I have demonstrated these changes were unable to doubt that the Fungus-germs, the Monads, and the Amœbæ were actually derived from the ultimate products of segmentation; and, further, that they were unable to suggest "infection" as an hypothesis that could possibly account for the many hundreds of similar changes taking place simultaneously in each fragment containing the different sets of Zooglœa.

When they have seen similar results themselves, what attitude can the critics take? If they see animal products, such as Monads and Amœbæ, taking origin from aggregates of primordial vegetal units like bacteria, and are compelled to recognise that such Monads, altogether independently of any possible inheritance, are enabled to throw out flagella, to come into being provided with a nucleus, and to develop actively functioning contractile vacuoles, will they still adhere to all their preconceptions, or will they rather admit their previous ignorance of nature's potency in this as well as in many other directions?

In a recent able article[5] on "Science and the Limits of Belief," Sir Ray Lankester dwells very forcibly upon "the importance of knowledge based securely on experimental demonstration and the examination of actual things." As he says: "It is precisely by the refusal to discuss possibilities, and by being at the same time willing and anxious to receive and verify tangible demonstration of a fact, however improbable it may appear," that all progress in science has ever been made. With this I absolutely agree; and can only trust that critics generally will adopt a like opinion.

Archebiosis is a process that always takes place beyond our ken, seeing that it must begin with mere molecular collocations, gradually going on to the formation of particles of an ultra-microscopic order. And the only explanation that seems possible of the growth of such particles into organisms like those found in the tubes, as well as of the appearance of the heterogenetic products that we have seen proceeding from Zooglœal segments, is to fall back upon an explanation which is generally admitted to account for all the known forms of crystalline matter. Molecular constitution, combined with the influence of the environment, is what we have to appeal to there; and, as Herbert Spencer over and over again insisted, the forms and structures of organisms, under the influence of what he termed "organic polarity," must be dependent upon like causes. In accounting for the lower forms of living matter, therefore, we may suppose, as he says,[6] that their "organic molecules of each kind, no matter how complex, have a form of equilibrium in which, when they aggregate, their complex forces are balanced."

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[4] As shown by Fig. 4. in Nature for January 22, 1914.

[5] In the R.P.A. Annual for 1915 (recently published

H. CHARLTON BASTIAN.

SMITHSONIAN GEOLOGICAL EXPLORATIONS.

DURING the past year, the Smithsonian Institution was represented in the field by nineteen parties and individuals engaged in the collection of data relative to astrophysics, geology, biology, and anthropology, besides nine representatives of the Bureau of American Ethnology, who secured information relative to the American Indian. While most of the exploration occurred in the United States, considerable work was carried on in Canada, the West Indies, Peru, Switzerland, Borneo, Cashmere, Egypt, Greece, and Italy.

A recent publication of the institution describing the various explorations, includes a report on the Palæontological field-work of the secretary, Dr. C. D. Walcott, in the Canadian Rockies, near the Robson Peak district in British Columbia and Alberta, and in Field, British Columbia. The mountainous scenery in the former region is quite alpine in appearance, including snow-capped and glacier-covered peaks which tower 7500 to 9800 ft. above Lake Kinney, itself some 3000 ft. above sea-level. On this trip Dr. Walcott's party approached from the west in order to study the invertebrate fossils in this section, which he considers one of the finest in the world. At the base of the mountain at Lake Kinney, there exist fossil beds, 4000 ft. or more in thickness, where a number of important ancient Cambrian fossil fauna were secured, as well as many examples of the species found in 1912. At Field, work was carried on in the great Cambrian fossil quarry, where, after blasting out the solid beds to a depth of 22 ft., a fine collection for the U.S. National Museum was secured.

Another geological research party was also in the field for fossils, but, instead of the very early forms of life sought by Dr. Walcott, this second party, under the direction of Mr. J. W. Gidley, was in search of fossil mammals from a later epoch. In this connection, the party again excavated in the Pleistocene cave deposit near Cumberland, Maryland, discovered in 1912, and found many new forms of mammals, and more complete remains of several species represented in the first collection solely by jaw fragments. The collection now numbers about 300 specimens, which represent forty or more distinct types of hitherto undescribed animals, many of which are now extinct, including the bear, peccary, wolverine, badger, martin, porcupine, woodchuck, dog and the American eland-like antelope. Other specimens found in less complete form were the mastodon, tapir, horse, and beaver, besides several smaller rodents, shrews, and bats. All these different animal remains occur intermingled and comparatively thickly scattered through the deposits of this ancient limestone cave, which was exposed by a cut made by the Western Maryland Railroad, and reported to the museum by Mr. Armbruster. Mr. Gidley is pursuing his studies in identifying these different remains, and expects to continue his excavations from time to time.

Mr. C. W. Gilmore, of the National Museum, conducted explorations in the north-western part of Montana, where some vertebrate fossil bones were discovered by a member of the Geological Survey in 1912. A total of more than 500 separate fossil bones was collected, among them a nearly complete skeleton of a new Ceratopsian or horned dinosaur, the smallest known of the great horned reptiles, and the first to be found having a complete articulated tail and hind-foot. Another find was a partial skeleton of the new Trachodont or duck-billed dinosaur, recently described from specimens obtained in Canada.

Dr. R. S. Bassler spent some time in the Appalachian Valley of Maryland studying the post-Palæozoic geologic history of the region as indicated by the present surface conditions, under the auspices of the U.S. National Museum, and the Maryland Geological Survey.

Another field research party which concerned the collection of fossils was maintained in Illinois by Mr. F. Springer, in connection with the preparation of his monograph on the fossil crinoidea, and to add to the museum collections of these fossil invertebrate marine animals. The field-work was undertaken in co-operation with the geological work of the State of Illinois, in order that the horizons from which these fossils were taken might be definitely determined. This resulted in securing several large cases of material, among which were several very large slabs containing numbers of specimens.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. E. G. FEARNSIDES, Miss F. M. G. Micklethwait, and Dr. E. P. Poulton have been elected to Beit Memorial Fellowships for Medical Research. Each fellowship is of the annual value of 250*l*.

THE third annual conference of educational associations will be held from January 4 to January 9, 1915, at the University of London, South Kensington. The inaugural address on the principles of educational science will be given by Bishop Welldon. In addition to the addresses and discussions in connection with the meetings of the Geographical Association, to which attention was directed in our issue of last week, mention may be made of the following contributions to the conference. At the meeting of the Froebel Society on January 4 Prof. J. J. Findlay will speak on educative toys and apparatus. On January 5 the Rev. Canon Masterman's presidential address to the Teachers' Guild will be on education for national service. The Provisional Committee for the Development of Regional Survey will meet on January 6, and a number of speeches will be delivered on regional survey in relation to education. During the evening of this date the School Nature Study Union will meet, and Mr. E. E. Unwin will speak on nature-study and the teacher. On January 8 the Science Teachers' Association holds its meeting, and Miss Muriel Robertson will speak on some sleeping sickness problems in Uganda; and on the same day Dr. G. R. Parkin will address the Association of Assistant-mistresses on the responsibilities of Empire.

THE annual Convocation of the Allahabad University for conferring degrees was held in November. The Chancellor, Sir James Meston, delivered an address which is reported in the issue of the *Pioneer Mail* for November 20. Towards the end of his remarks he said:—"My sole aim is the greater efficiency of our University. Now there are two kinds of efficiency. One kind, wrongly so called, seeks for a mechanical perfection, an official symmetry, a standardising of work and ideals with little thought for human weakness and human reticences. Such is the Teutonic form of efficiency, against which the armies of England and India are battling in Europe at this moment. The efficiency which we want in the India of to-day is of a different and a better type. It seeks for a steady improvement of the conditions which stimulate self-development; it does not despise the feelings and frailties of mankind; and it moves through the portals of conviction towards the goal of the ideal. It is in this sense that efficiency must ever be the rally-cry of our University. We can never stand still but must always move forward, striving for the best, with a divine discontent for all the spurious imitations and the makeshifts which we may be asked to accept in its place. In the ordinary life of the world we have constantly to endure the second best or something still poorer, in art, in music, in literature, in our companionships. But let us not foist the second best, if we can help it, on our students. The temptations to be content with it will assail them soon enough. Be it our part to give them the best we can command, and to help them to enjoy and desire it. In this way shall we raise the true efficiency of our University and ensure for our graduates their proper place in the van of Indian progress."

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[6] "Principles of Biology" (revised edition, 1898), vol. i., Appendix D, p. 704.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, December 1.—Mr. F. Nicholson, president, in the chair.—C. H. **Lander**: Graphical determination of the stresses in the main spars of monoplanes. One of the most complex problems connected with the design of beams continuous over several supports is presented by the main spars of monoplanes. The stresses are made up of direct compressions and those due to bending moments, the determinations of the latter being most complicated. The lift of a wing surface for small angles increases with the angle of incidence and with the square of the velocity: at a speed of about 60 miles per hour the lift of a certain type of curved wing varies from 5 lb. at 4° up to a maximum of 11·7 lb. at 17°; at 120 miles per hour these lifts would be four times as great. Most monoplanes are designed for a load of $0{\cdot}007V^2$lb. per square foot, V being the designed speed in feet per second. From this the loading on the spar may be determined for different angles. The method of solution of the stresses then varies according to the manner in which the lift wires are attached to the spar. The direct application of Claxton Fidler's method of solution of continuous beams may be used when the lift wires are attached to the spar at the neutral axis. When these wires are attached at the lower side of the spar, the longitudinal moments induced may be assumed and their diagrams plotted as though the spars were discontinuous over the points of support, characteristic points obtained, and the true base line drawn by Fidler's method. A modification of Fidler's method can also be used in the case of wires badly adjusted or injured.—Prof. W. H. **Lang**: Studies in the morphology of Isoëtes. Pt. I.—The general morphology of the stock of Isoëtes. The external form and gross anatomy of the two-lobed stock of *Isoëtes lacustris* is described. The upper portion of the stock corresponds to the shoot, the lower portion behaves as a downwardly growing rhizophore, on which roots arise in acropetal succession. The position of the deeply-seated growing line of the rhizophoric region corresponds to that of the secondary meristem of the base of the stem, but its mode of growth is different. The growth proceeds, and the roots are brought to the surface, as if the lower apex were not only drawn out and deeply sunken, but the opposed sides of the depression were congenitally united. When the roots are exposed by the splitting process at the groove they stand exogenously on the surface. This mode of interpreting the morphology of Isoëtes proves satisfactory when applied either to the explanation of the growth of the stock itself or in comparisons with Lepidodendreæ and Pleuromeia. The rhizophoric region of the stock of Isoëtes is regarded as the structure in existing plants most closely comparable to the stigmarian base of the Lepidodendreæ.

December 15.—Mr. F. Nicholson, president, in the chair.—F. R. **Lankshear**: Quantitative absorption spectra. Part ii.—A new ultra-violet photometer. A new ultra-violet photometer was described, in which, by a system of condensers and prisms, two equal beams of light are obtained. One beam passes through the absorbing liquid and the other through a central adjustable sector. Corrections due to the intermittent nature of light thus become unnecessary.—W. C. **Jenkins** and E. L. **Rhead**: Some notes on aerolites: the Appley Bridge aerolite of October 13, 1914. A summary of observations made on the mass found at Appley Bridge, and the results of preliminary analyses of its chemical composition.

PARIS.

Academy of Sciences, December 7.—M. P. Appell in the chair.—Haton de la **Goupillière**: A property of arithmetical progressions.—J. **Bosler** and H. G. **Block**: Observations of the eclipse of the sun of August 21, 1914, made at Strömsund (Sweden) by the expedition from Meudon Observatory. The main object of the expedition was to photograph the spectrum of the corona in the whole visible field, including the red, and, if possible, obtain some indications of its velocity of rotation. The weather conditions proved extremely favourable. The results of the observations are summarised on p. 460.—M. **Skossarewsky**: The electrolytic dissociation of acetylene and its metallic derivatives. The electrolytic dissociation of acetylene and its monosodium derivative has been proved by measurements of conductivity in solution in liquid ammonia. The dissociation increases with the dilution of the solution. The temperature coefficient of the specific conductivity is about 2 per cent. for 1° C., and is nearly independent of the concentration.—M. **Tiffenau**: Molecular transposition in the *cyclo*hexane series: passage to the *cyclo*pentane series. Orthoiodo-hydroxy*cyclo*hexane, treated with silver nitrate, gives the aldehyde of *cyclo*pentanecarboxylic acid. The removal of hydriodic acid causes the opening of the ring, and passing from a *cyclo*hexane to a *cyclo*pentane derivative. Homologues of the *cyclo*hexane alcohol behave in a similar manner.—Marcel Le **Brazidec**: Molecular transposition in the phenyl*cyclo*hexane series: migration of a phenyl group without passage to the *cyclo*pentane series. Iodophenyl*cyclo*hexanol, on elimination of hydriodic acid with silver nitrate gives phenyl*cyclo*hexanone, a *cyclo*pentane derivative not being formed.—C. **Grossmann**: The uranium minerals of Fiadanana, Madagascar. Externally the mineral resembles euxenite and contains from 12 to 40 per cent. of Ur_3O_4. The mineral with the higher proportion of uranium possesses a radio-activity nearly double that of pure black uranium oxide, and may prove a possible source of radium compounds.—Maurice **Lugeon**: Some consequences of the presence of crystalline sheets underlying the Niesen zone (Switzerland).—Fernand **Guéguen**: The alteration termed "piqûre" of sail and tent canvas. The loss of strength of canvas in certain spots after exposure to the open air is shown to be due to the development in the tissue of various moulds. It does not seem to be due to accidental contamination of the fabric, but is caused by the development, under the influence of moist heat, of filaments of mould present in the new material. Sterilisation by steam is suggested as the most practical means of dealing with the trouble.

BOOKS RECEIVED.

Electrical Engineering in India. By J. W. Meares. Pp. xxxvi+517. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 15*s*.

Preparations and Exercises in Inorganic Chemistry. By W. Lowson. Pp. vii+128. (London: Methuen and Co., Ltd.) 2*s*. 6*d*.

Mikrographie des Holzes. By Dr. J. W. Moll and H. H. Janssonius. Vierte Lieferung. Pp. 336. (Leiden: E. J. Brill.)

The Fauna of British India, including Ceylon and Burma. Mollusca II. (Trochomorphidæ—Janellidæ). By G. K. Gude. Pp. xii+520. (London: Taylor and Francis.) 20*s*.

Memoirs of the Geological Survey, Scotland. The Geology of Caithness. By C. B. Crampton and R. G. Carruthers. Pp. viii+194. Sheets 110 and 116, to accompany the foregoing. (London: H.M.S.O.; E. Stanford, Ltd.) 4*s*.

Magnetism and Electricity, including the Principles of Electrical Measurements. By S. S. Richardson. New edition. Pp. ix+598. (London: Blackie and Son, Ltd.) 4*s*. 6*d*.

Pottery, for Artists, Craftsmen, and Teachers. By G. J. Cox. Pp. ix+200. (London: Macmillan and Co., Ltd.) 5*s*. 6*d*. net.

Canada. Department of Mines. Geological Survey. Memoir 41. The "Fern Ledges" Carboniferous Flora of St. John, New Brunswick. By M. C. Stopes. Pp. vi+142+xxv plates. Memoir 54. Annotated List of Flowering Plants and Ferns of Point Pelee, Ont., and Neighbouring Districts. By C. K. Dodge. Pp. 131. Mines Branch. Lode Mining in Yukon. By T. A. MacLean. Pp. ix+205. The Copper Smelting Industries of Canada. By Dr. A. W. G. Wilson. Pp. xiv+184+plates. (Ottawa: Government Printing Bureau.)

The Rare Earths: their Occurrence, Chemistry, and Technology. By S. I. Levy. Pp. xiv+345. (London: Edward Arnold.) 10*s*. 6*d*. net.

Numerical Trigonometry. By N. J. Chignell. Pp. 126+xii. (Oxford: Clarendon Press.) 2*s*. 6*d*.

The Principles and Practice of Judging Live-Stock. By Prof. C. W. Gay. Pp. xviii+413. (London: Macmillan and Co., Ltd.) 6*s*. 6*d*. net.

The Chemistry of Cyanogen Compounds and their Manufacture and Estimation. By H. E. Williams. Pp. viii+423. (London: J. and A. Churchill.) 10*s*. 6*d*. net.

Huxley Memorial Lectures to the University of Birmingham. With an Introduction by Sir Oliver Lodge. Pp. 157. (Birmingham: Cornish Bros., Ltd.) 5*s*. net.

Hazell's Annual for 1915. Edited by T. A. Ingram. Pp. 592. (London: Hazell, Watson, and Viney, Ltd.) 3*s*. 6*d*. net.

The Chemistry of the Radio-Elements. By Prof. F. Soddy. Part i. Second edition. Pp. viii+151. (London: Longmans and Co.) 4*s*. net.

Catalogue of the Lepidoptera Phalænæ in the British Museum. Supplement, vol. i. Catalogue of the Amatidæ and Arctiadæ (Nolinæ and Lithosianæ) in the Collection of the British Museum. By Sir George F. Hampson. Pp. xxviii+858. (London: Longmans and Co., and others.) 25*s*.

The Pupil's Class-Book of Geography: The British Dominions. By E. J. S. Lay. Pp. 128. (London: Macmillan and Co., Ltd.) 6*d*.

First Book of Physiology and Hygiene. By G. D. Cathcart. Pp. vi+158. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Scottish National Antarctic Expedition. Ornithology of the Scottish National Antarctic Expedition. By W. E. Clarke, Dr. R. N. R. Brown, and L. N. G. Ramsay. Pp. 203–306+vii plates. The Seals of the Weddell Sea: Notes on their Habits and Distribution. By Dr. R. N. R. Brown. Pp. 185–198+ix plates. (Edinburgh: Scottish Oceanographical Laboratory.) 11*s*. and 3*s*. 6*d*. respectively.

Science and Religion. By Seven Men of Science, speakers in Browning Hall during Science Week, 1914. Pp. 138. (London: W. A. Hammond.) 1*s*. net.

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THURSDAY, DECEMBER 31, 1914.

CALCULATING DEVICES.

Modern Instruments and Methods of Calculation. A handbook of the Napier Tercentenary Exhibition. Edited by E. M. Horsburgh. Pp. vii+343. (London: G. Bell and Sons, Ltd., and The Royal Society of Edinburgh, n.d.) Price 6*s.* net.

ALL who are interested in the history or the methods of calculation owe a debt of gratitude to the editor and the committee who have produced this valuable book. It is in the recollection of everyone concerned in mathematical operations that the Royal Society of Edinburgh held a great celebration in July last, three hundred years after the publication, by John Napier, of his admirable Canon of Logarithms. This was attended by learned delegates from many distant countries, as well as by a number of our own countrymen. Greatly as many must have regretted their inability to be present on account of duties elsewhere, this regret will not be lessened by a perusal of the book now under review, for from it they will learn what a magnificent collection was available for inspection and discussion. This collection of tables, books, portraits, and instruments of various kinds, which must have appealed to the historic as well as the utilitarian and mechanical instincts of those who were fortunate to be able to attend the celebration, form the basis upon which the present work is constructed, for it is in minor part catalogue and in major part a series of descriptive articles by experts in the several branches.

Seeing that the price asked for a large octavo book of 343 pages and containing a very large number of excellent illustrations is only six shillings, those who are interested should feel that, like the Nautical Almanack, the work is in effect a gift, the price doubtfully covering the cost of production.

The first section, by Prof. G. A. Gibson, deals with the life of Napier, of his great invention of logarithms, of his meeting with Briggs, and matters mainly of personal and historical interest. Here we read how Napier formulated his ideas of the logarithm which was derived, not from algebraic methods, as is now found to be most convenient, but upon the relative values of the portions of two lines determined by the motion of two points, one moving uniformly and the other, starting at the same, but moving with diminishing velocity such as to be proportional in amount to the length of the part untraversed. He thus made his logarithms without reference to a base, and the logarithm of "the whole sine" (the sine of 90°) becomes zero, the logarithm of positive quantities less than unity is positive, and of quantities greater than unity is negative. Curiously, hyperbolic logarithms to the base e are not those that Napier calculated, but logarithms to the base $1/e$. It is difficult to realise now that highly convergent series for logarithms are universally understood how Napier could have calculated as he did the logarithmic series and tangents of all angles from 0° to 90° by intervals of one minute of arc, and this long before the days of the binomial theorem. In this chapter we learn incidentally that Napier invented the decimal point, and we find also a description of the well-known "bones."

The next two sections are very largely in the nature of catalogues of the articles in the loan collection and of the collection of mathematical tables, but descriptive articles are included, of which one on portable sun-dials, by J. R. Findlay, and an account, written by Dr. Knott, of the great manuscripts by Dr. Sang, given by his daughters to the Royal Society of Edinburgh, may in particular be mentioned, as also the concluding article, by W. G. Smith, on the special development of calculating ability in prodigies or "calculating boys."

The further chapters are as follows: "Calculating Machines," by F. J. W. Whipple, but including special articles by P. E. Ludgate and T. C. Hudson; "The Abacus," by Dr. Knott; "Slide Rules," by G. D. C. Stokes; "Other Mathematical Laboratory Instruments," by a number of specialists. As this chapter includes such varied and elaborate instruments as integraphs, planimeters and their use in naval architecture, harmonic analysers, tide predictors, machines for drawing conic sections, for solving equations and precision plotting, many of which are well illustrated and explained by a number of authors having special knowledge, it will be evident that this is one of the most technically difficult and illuminating in the book. Among remaining chapters may be mentioned that on ruled papers and nomograms, which latter are graphical devices by means of which numerical solutions may be found for equations involving several variables. For instance, in the general equation for a spherical triangle showing the relationship between any angle and the three sides, Prof. D'Ocagne has given a nomogram from which, if three of the six quantities are given, the other three can be determined by the aid of a stretched thread.

The chapters relating to calculating mechanism contain descriptions of numerous recent additions to our resources in this direction which as yet are but little known, and interesting to many as a discussion of the novelty and advantages of these would be, it would be impossible to do justice to the subject without occupying far more space than is available. Dr. Knott's chapter on the abacus, also, is one which it would be delightful to follow if only space allowed, for the description of the mental process followed by the Japanese when making their lightning speed calculations with the abacus, of their inverse way of effecting division, and, in general, of the manner in which they work off figure by figure the problem set upon the abacus as it is done with to make room for the new figure in the result; all are full of interest, and a careful study of this chapter would be likely to modify the complacency with which the European in general contemplates the Asiatic as a computer with wires and beads.

C. V. BOYS.

OIL OF VITRIOL AS AN AGENT OF "CULTURE."

The Manufacture of Sulphuric Acid and Alkali with the Collateral Branches: a Theoretical and Practical Treatise. By Prof. G. Lunge. Fourth edition. Vol. i.: Sulphuric Acid. Part i., pp. xxiv + 582. Part ii., pp. xii + 583–1078. Part iii., pp. xii + 1079–1617. (Gurney and Jackson, 1913.) Price, vol. i. (in 3 parts), 3*l.* 3*s.* net.

PROF. LUNGE'S monumental work on the manufacture of sulphuric acid is one of the acknowledged classics of chemical technology, and the soundest proof of its continued merit and widespread appreciation is seen in the circumstance that it has now reached its fourth edition. The subject is admittedly of great complexity. The manufacture is one of the great staples of chemical industry, and lies, in fact, at the basis of that industry in general.

Indeed, it is impossible to conceive of the position of chemical industry, and of the industries dependent upon it, if the world were suddenly bereft of sulphuric acid. If we could deprive Germany, for example, of all means of manufacturing or otherwise procuring oil of vitriol, not only would her chemical industries languish, but even her capacity for military offence or defence would be effectually checked since the use of this acid is indirectly, but nevertheless absolutely, necessary for the manufacture of those high explosives upon which her artillery, the strongest arm of her service, wholly depends. She has, of course, internal means of supply, but these are by no means limitless, and there are already signs that she is within measurable distance of the end of her resources as regards the provision of the raw materials needed for the manufacture. Liebig once said that we might gauge the civilisation of a country by the amount of this acid it consumed. It would appear, therefore, that the continued forcible dissemination of German "culture" is largely dependent upon a German supply of oil of vitriol.

But, of course, it is the arts of peace that mainly consume the oil of vitriol the world requires, and there is scarcely a process of manufacture that could be named that does not need it either directly or indirectly.

It is difficult to obtain a trustworthy estimate of the aggregate output at the present time, but from the statistics referred to by Dr. Lunge it is probably not fewer than five million tons, of which not less than a fifth, and probably more, were, prior to the outbreak of war, made in Germany, mainly from imported iron pyrites.

In addition, Germany has hitherto imported a gradually increasing quantity of oil of vitriol, amounting in 1911 to 99,653 tons. At the present time, therefore, she is almost wholly dependent upon the employment of zinc-blende, the relatively poor German pyrites, the mixed ores from Freiberg, and Mansfeld, and the small quantity from gas-oxide. It may be anticipated, therefore, that the serious economic disturbance consequent upon the invasion of her eastern frontier will very largely affect her ability to maintain her supply.

In the case of a substance of such world-wide application as sulphuric acid it need scarcely be said that there is a very strenuous industrial competition, and there is probably no branch of chemical technology which has been more thoroughly developed than its manufacture, and to-day its production is studied, watched, and controlled with all the precision of a vast scientific experiment in which all the resources of modern chemical, physical, mechanical, and engineering knowledge are brought to bear. The main principles of its manufacture are in all probability definitely established, but so fierce is the competition and so bountiful the trained skill and intelligence concentrated upon its economic production, that each succeeding decade sees some new departure, often of fundamental or far-reaching importance. It is a duty which the veteran author has imposed upon himself in the days of his retirement from the active work of his professorship, to take note of these changes, and to embody them in successive editions of the great work with which his memory will always be associated. That he may long be spared to continue this self-imposed task is the sincere hope of every well-wisher to the progress of that great branch of technology of which Dr. Lunge has been for so many years so distinguished an exponent.

T.

TWO MATHEMATICAL COURSES.

(1) *The Theory of Numbers.* By Prof. R. D. Carmichael. Pp. 94. (Mathematical Monographs, No. 13.) (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 4*s*. 6*d*. net.

(2) *Lectures Introductory to the Theory of Functions of Two Complex Variables.* Delivered to the University of Calcutta during January and February, 1913, by Prof. A. R. Forsyth. Pp. xvi+281. (Cambridge: University Press, 1914.) Price 10*s*. net.

THESE works are mainly interesting as examples of the trend of instruction given to university students who are just beginning to specialise. One is based upon two years' teaching in Indiana University; the other is the substance of a course delivered, by invitation, at the University of Calcutta, with, presumably, a number of Indian students in the audience. Both courses agree in the endeavour to trace the main outlines of the argument, to give really illustrative examples, and to avoid excessive detail on particular points of minor importance.

(1) Prof. Carmichael does not advance beyond well-beaten and classical ground, so that he has little opportunity of introducing really modern ideas. All but one of his six chapters deal with such things as ordinary factorisation of integers, elementary congruences, Fermat's theorem, and primitive roots. Chapter vi. is a miscellany in which there is a statement, without proof, of the law of quadratic reciprocity for two odd primers; a very brief account (with references, fortunately) of some special Galois imaginaries, and some interesting samples of the true Diophantine analysis. Some of the harder examples are novel and interesting, *e.g.* "The number of divisions to be effected in finding the G.C.M. of two numbers by the Euclidean algorithm does not exceed five times the number of digits in the smaller number (supposed written in the decimal scale)."

Without advising any improper and premature specialisation, it may be fairly urged that some of the work contained in this course might be done at school; the G.C.M. theory, and that of linear congruences, at any rate. Familiarity with the congruence notation is so important that its introduction ought not to be deferred.

(2) Prof. Forsyth has undertaken the difficult task of giving an outline of the known theory of functions of two independent (complex) variables, together with an account of what he calls "triple theta-functions." Everyone who has studied this theory at all is aware that it suggests theorems similar to those of Gauss, Green, Cauchy, etc., for functions of one variable, but that it is very difficult to prove them in an analogous, so to speak, geometrical way, mainly because while a plane or a sphere gives us a graphic picture of the field of one complex variable, we cannot at present realise a convenient image of the field of two independent complex variables. It is easy enough to make images of a sort; for instance, take two planes, plot off the independent variables, x, y, in the usual way on each, and now associate with a given pair (x', y'), the line joining the point which is the image of x' to that which is the image of y'. An obvious objection to this is that the meet of the planes does not correspond to a unique pair x', y', and there are other inconveniences connected with the difficulty of visualising linear complexes and congruences. After reviewing various proposals, Prof. Forsyth concludes that the only practicable way at present is the purely analytical one, following the methods of Weierstrass and his school. It is to be hoped that this is not the final word on the question; at any rate, there are papers by Picard, Appell, and Poincaré which ought to stimulate those whose ideas naturally clothe themselves in geometrical forms.

Features of the course which should be noted are: (1) the introduction of *two* dependent variables, now and then, as functions of two independent variables; the use of this is analogous to that of one-one transformations of plane curves; (2) in the chapter on integrals, where we have *two* algebraic functions introduced, so that the independent variables are arbitrary; (3) the theory of the so-called "triple theta-functions." The characteristic equations of these functions are given in the form:

$$\vartheta(z+1,\ z') = \vartheta(z,\ z'+1) = \vartheta(z,\ z')$$
$$\vartheta(z+\mu,\ z'+\mu') = \exp.\{-2\pi i(2z+2z') - 2\pi i(u+\mu')\}\,.\,\vartheta(z,\ z').$$

Hence the author derives double Fourier expansions for the functions, which fall into a co-ordinate set of sixteen; various tables and formulæ relating to them are given. The course concludes with a sketch of the theory of quadruply periodic (double) theta-functions, and their algebraic relations.

It seems to us that this course is not quite so well-proportioned or up-to-date as that of Prof. Osgood, recently published, on the same subject; but the difference of object and of audience must be allowed for. At any rate, we have a useful guide to the work of Weierstrass and Picard, a certain amount of new, although not very fundamental, theory; some instructive and original examples; and, it need scarcely be said, an elegant analytical presentation of the subjects treated.

G. B. M.

THE LONDON HOSPITALS AND THEIR FUTURE.

Historical Account of Charing Cross Hospital and Medical School (University of London) Original Plan and Statutes, Rise and Progress. Founded 1818. *With which is included some Account of the Origin of the other Hospitals and Schools in London.* By Dr. W. Hunter. Pp. xx + 309. (London: John Murray, 1914.) Price 21*s.*

THE rise and development of the "teaching" hospitals of London is intimately associated with the progress of medical science in England; besides being the homes of medical education, much excellent research work, particularly on the clinical side, has emanated from their walls.

In a sumptuous volume, embellished with a wealth of illustrations and reproductions of old prints, Dr. William Hunter, its "Dean," reviews the history of Charing Cross Hospital. He classifies the modes and motives of origin of the London hospitals as follows:—(1) The *Monastic* (afterwards charitable), *e.g.* St. Thomas's and St. Bartholomew's; (2) the *Charitable, e.g.* Westminster, the London, St. George's, etc.; (3) the combined *Charitable* and *Educational,* for which Charing Cross Hospital was founded; and (4) the *Educational,* University and King's College Hospitals.

Founded by Dr. Benjamin Golding in 1818, the fortunes of Charing Cross Hospital were directed by him for a period of well-nigh fifty years. Of its many distinguished students, the name of Huxley is the most prominent, and his memory is perpetuated in the biennial Huxley Lecture delivered at the school.

The Charing Cross Medical School has continued to progress, and one of the latest developments is the housing of the Public Health Department of King's College within its walls—a form of concentration in one branch of medical education which to some extent falls into line with the conceptions of the Royal Commission on University Education in London.

Although the report of this Royal Commission foreshadows many changes in medical education, there seems little prospect of State control of the hospitals—indeed, the voluntary system of support appears to be in a stronger position than ever. When the first Employers' Liability Bill came into force many came to the conclusion that this was the thin end of the wedge for State control, and the second and more far-reaching Act seemed to confirm this opinion. As a matter of fact, however, the voluntary hospital system has gone on, and as the public became accustomed to these Acts, the hospitals continued not only as well as before, but most of them with improving revenues. Even the appearance of the National Insurance Act upon the scene has made no difference—most of the hospitals receive better support than ever from the public, and the King Edward's and other funds are thriving beyond all expectation. On one hand, it is true, the voluntary system has disadvantages. It is the generous and sympathetic portion of the public that supports the hospitals, and others shirk their responsibilities. On the other hand, the poor obtain better treatment than they could probably obtain in State supported hospitals. There is a blaze of light on the British voluntary system that is entirely absent from the continental State hospitals and in hospitals under the Poor Law. Even if the present voluntary hospitals were taken over by the State, it is almost certain that new ones would immediately be founded, as has been the case in Paris (*e.g.* the Hertford Hospital).

There might well be some modification of the hospital system in London. The sick should so far as possible be removed from the densely populated centres more into the country. That large blocks of wards should be erected on costly sites in the heart of London is a mistake—both financially and from the medical point of view. All that is required at the centre is accommodation for receiving rooms and for a sufficiency of beds for the reception of accidents and emergencies and for the treatment of the very ill. All the other cases, and the serious cases as they convalesce, should be removed to hospital wards erected more in the country. In these days of motor transport and improved road surfaces this would be an easy matter, and the staff by the same means could minister to the sick almost as readily on the slopes of Hampstead as at Hyde Park Corner.

R. T. HEWLETT.

SCIENCE AND METAPHYSICS.

(1) *Henri Bergson: An Account of his Life and Philosophy.* By A. Ruhe and N. M. Paul. Pp. vii + 245. (London: Macmillan and Co., Ltd., 1914.) Price 5*s.* net.

(2) *The Idealistic Reaction against Science.* By Prof. Aliotta. Translated by A. McCaskill. Pp. xxii + 483. (London: Macmillan and Co., Ltd., 1914.) Price 12*s.* net.

(3) *Berkeley and Percival.* By Benjamin Rand. The Correspondence of George Berkeley afterwards Bishop of Cloyne, and Sir John Percival afterwards Earl of Egmont. Pp. x + 302.

(Cambridge University Press, 1914.) Price 9*s*. net.

(1) IF a layman may presume to criticise the professional metaphysician, one may say that the merit of M. Bergson is to have freshened up philosophy. His point of view is *nullius addictus jurare in verba magistri*, and he has successfully cast off all the trammels not only of the old cut and dried philosophy of the schools, but even the gaseous mysticism of Neo-Hegelianism. Yet some style him a Neo-Hegelian. Philosophy, he says, should be moulded on experience, and experience both changes and grows with human development. There is something of most philosophies in M. Bergson's attitude to the universe, for his philosophy is simply this: it is everything but a system. He is neither monist nor pantheist, but, as it were, a layman trying to understand. This attitude of his is optimistic; he has confidence in the universe. It may seem that he, like other exponents of "the new philosophy," has a quarrel with monism and materialism, but he himself has deprecated all philosophical quarrels, for after all philosophy is only our attitude to and conception of the Absolute, and the wise man simply absorbs the positive results of all philosophies.

M. Bergson has given movement to metaphysics; he has charmed it with change. Change is "the very basis of all reality." To drive home his dynamic idea of reality, he employs phrases. In such a subject nothing else can be employed, for metaphysics is not science. It is at its best and it is most useful when it does not aim at being a science. The French philosopher is akin to the Greek Heraclitus, who preached eternal flux, and Heraclitus coined some great phrases. M. Bergson observes that "the animal is a specialist." It is a well-known truth, but has never been put so neatly. M. Bergson's demerit perhaps is his animism. He has studied most branches of science, but the only positive hint he derives from them is a "creative evolution," which is simply vitalism writ large. He speaks of "the idea of a God, Creator and free, the generator of both matter and life, whose work of creation is continued on the side of life by the evolution of species and the building up of human personalities." This may be pragmatic (though he would resent the imputation), but it amounts to very little. Equally *a priori* is his observation that "the brain apart from its sensorial functions has no other office than to exhibit in pantomime the mental life." It is scarcely fair, again, to credit the parallelist with supposing "that memories are somehow hung on the brain, as though a telephone conversation should remain on the wire." On the whole, M. Bergson strikes one as a brilliant epigrammatist, illuminating with modern flashes of insight the ancient and permanent text of Aristotle, "the principle of life is a God; for energy of mind constitutes life, and God is this energy. He, the first mover, imparts motion and pursues the work of creation as something that is loved." The phrase is worthy of Bergson, but the argument is in a circle.

(2) Signor Aliotta criticises with some volume the idealistic reaction against science in modern thought. He himself holds "a spiritualistic realism" by means of which he can defend scientific method and natural reality against the irrationalism of Neo-Hegelianism. His volume is remarkable as including criticism of every scientific and philosophic hypothesis and method of the last hundred years. Both Aliotta and Bergson show how modern philosophy aligns itself with science. All its deductions are based on some scientific theory. Signor Aliotta is at one with M. Bergson and other moderns in having done with scholasticism and systematism. "Concrete thought is not a cold abstract conception, but experience seen in the glow of the idea which breathes the warmth of feeling, and is moved by the energetic impulse of spontaneous volition, which inspires it with the enthusiasm of faith." "We must replace the static conception of the object which regards it as complete in itself in an inaccessible sphere by a dynamic view which beholds it in its progressive ascent to a higher form of knowledge and reality." He attempts to effect a *rapprochement* between idealism and realism, a laudable effort. Whereas Bergson finds in "intuition" the crucible of nature, Aliotta regards reason as "the final goal at which an experience aims and to which by its means all the beings in the world tend." This is teleology and presumes an Absolute Consciousness. "Nature does not exist only in the mind of man, but also outside our thought." "He who believes in the objective value of his science must then also believe in God. If an Absolute Thought does not exist, nature cannot be rational, and if there is no rationality in things, the reconstruction which we make of them with the categories and principles of our mind is an arbitrary projection of no value whatsoever."

(3) Such critical reflections would have interested Berkeley, the theorist of vision and the theistic idealist, who argued for the non-existence of matter. Existence and reality are terms which have borne the burden and heat of philosophers' tongues. Why not admit everything to be real? Berkeley's letters, hitherto unpublished, contain nothing of scientific or philosophic interest. They

only show concern as to the reception of his books, and a general interest, as of a man of the world who was also a prelate, in the doings of great personages. His famous excursions into science and metaphysics seem to have been such *tours de force* as have always been executed by brilliant public men.

In a sense Berkeley was an eighteenth-century Bergson. His naïve development of the thesis that judgment is involved in every act of vision was consonant with the then state of psychology. In his metaphysics he turned out matter, in order to introduce the living God. The being of the sense-world consists in its being perceived. The remark of Clarke and Whiston, themselves professional metaphysicians, deserves immortalisation; they expressed, when invited to criticise Berkeley, regret for "the waste of his extraordinary genius on metaphysics."

A. E. CRAWLEY.

OUR BOOKSHELF.

Modern Tunneling: with Special Reference to Mine and Water-supply Tunnels. By D. W. Brunton and J. A. Davis. Pp. vi+450. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1914.) Price 15*s.* net.

THE matter in this book is confined chiefly to tunnels and adits for mining purposes, and includes also those used to carry water for power, irrigation, and domestic use. Such tunnels are driven generally through fairly hard rock. Some cross-sections of typical tunnels are given, and extensive bibliographies are supplied which will be of assistance to the engineer responsible for the design of a tunnel. The bulk of the book, however, is taken up with descriptions of methods of executing tunnels. The authors are evidently experts in such work, and give capital discussions on such subjects as the choice of power for tunnel work, air compressors, ventilation, rock-drills, haulage, blasting, and timbering.

The section dealing with precautions which should be taken by the manager in order to ensure the safety of the workmen is of particular interest. In 1911 an average of nearly four men per 1000 employed in and about the metal mines of the United States were killed; 3·8 per 1000 in coal-mining were killed in the same period. These accidents are not entirely preventable, but much of the present mortality and injury is the result of ignorance or gross carelessness, and can be avoided. When, for instance, a man sees fit to thaw frozen dynamite in a frying-pan, or by a candle flame, there is nothing accidental about the explosion which ensues. Many managers also are either ignorant of ordinary precautions or most negligent in seeing that they are properly and consistently carried out. The fall of a slab of rock weighing anything less than one ton should be charged at once to carelessness.

The authors give a long list of don'ts, and include notes of warning regarding intoxication, which, as a contributory cause of accidents, is too little appreciated. Even a slight degree of intoxication is dangerous underground, where it is very apt to be greatly aggravated by lack of fresh air and by heat. Most of the processes described relate to American practice, but British engineers will find much to interest them in this volume.

Jute and Linen Weaving. By T. Woodhouse and T. Milne. Second edition. Pp. xxvii+590. (London: Macmillan and Co., Ltd.; New York: The Macmillan Company, 1914.) Price 12*s.* net.

THIS book must be ranked among the classics in technical literature. There is a thoroughness and completeness about it that appeals equally to the elementary student of weaving, to the experienced textile engineer, and to all those occupying responsible positions in the weaving departments of the textile industry.

Whilst the book is written around the title and deals with the subject of jute and linen weaving, a very considerable portion is equally valuable to the cotton and other sections of the trade; in fact, it may be looked upon as a very comprehensive exposition of the subject of weaving in general, for most of the problems and mechanism connected with weaving are fully treated.

For a book of this character to require a second edition is clear evidence of the very high appreciation in which it is held. The authors have taken advantage of this issue to add considerably to its value by the inclusion of some 108 new illustrations with their corresponding explanations, and much new matter has been incorporated. The 582 pages are divided up into twenty-two chapters ranging from an explanation of counts, through a very complete description of preparing machinery of almost all types, arrangements and details of looms, and their special purposes with minute particulars of their functions and products.

The newest chapters include automatic weft supply mechanisms, the chain linking machine, terry or turkish towel motions, warp stop motions, the latest box motions and jacquards, and an interesting chapter on electric driving of individual looms.

To all who are interested in jute and linen weaving and even to those who are chiefly concerned in other sections of manufacture, this book can be recommended as an unusually valuable text-book, and the authors are to be complimented on attaining such a high level in their treatment of the subject.

The Indian Museum, 1814–1914. Pp. xi+136+ appendixes. (Calcutta: Trustees of the Indian Museum, 1914.)

ONLY Anglo-Indians who, like the present writer, can recall the days when—in the early middle 'seventies—the natural history and antiquarian collections of the Asiatic Society of Bengal were crammed into an ordinary-sized dwelling-house in Park Street, while those of the Geological Survey, together with its offices, were housed in a business tenement near the river, are capable of realising and appreciating the contrast between the present and the past in respect to the status of science and art in the City of Palaces. The change was great enough when the Chowringhi "jadu-gahr" (home of magic), as the Indian Museum is invariably termed by Bengalis, was first opened during the later 'seventies, but the present enlarged building, as photographed in the volume before me, with its additional upper storey and doubled frontage, renders the original structure almost a doll's house in comparison, magnificent and spacious as it was thought to be at the time when the present writer assisted in arranging the galleries.

In housing in this magnificent and lavish style the valuable collections illustrating the natural history, geology, archæology, and ethnology of British India, the Indian Government has done its duty in a manner worthy of all praise. Whether, however, the attempt to make the museum a great centre of educational instruction in biology will ever be realised, seems, to quote from the admirable account of the rise and history of the collections given by the Hon. Justice Sir A. Mookerjee in the introduction to the volume, more than doubtful. The introduction is followed by accounts of the various departments of the museum, all written in a style which renders the volume a model of what a work of this nature should be, and a credit to all those concerned in its production.

R. L.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Colon as a Symbol for Ratio and Division.

IN 1902 Prof. W. W. Beman, of the University of Michigan, pointed out ("L'Intermédiaire des mathématiciens," T.9, Paris, p. 229, question 2424), that the colon (:) occurs as a designation of geometric ratio at the end of the trigonometric and logarithmic tables published, together with William Oughtred's "Trigonometria" of 1657. Beman inquires whether this symbol for geometric ratio has a still earlier date.

Before answering this question we remark that it is highly improbable that the colon occurring in those tables was inserted by Oughtred himself; in the "Trigonometria" proper the colon does not occur, and Oughtred's regular notation for ratio and proportion, A . B ∷ C . D, is followed throughout.

In the English edition of Oughtred's "Trigonometrie," printed in the same year, 1657, but subsequent to the Latin edition, the passage of the Latin edition containing the : is recast, the new notation for ratio is abandoned and Oughtred's regular notation introduced.

In Oughtred's posthumous "Opuscula mathematica hactenus inedita" (Oxford, 1677), the colon (:) is used frequently, but it may have been introduced by the editor of the book.

In answer to Beman's inquiry, we remark that the colon (:) was used to designate geometric ratio some years before 1657 by at least two authors, Vincent Wing, the astronomer, and a schoolmaster who hides himself behind the initials "R. B." Wing wrote several works. In 1649 he published in London his "Urania Practica," which, however, exhibits no special symbolism for proportion. But his "Harmonicon Coeleste" (London, 1651) contains many times Oughtred's notation A . B ∷ C . D, and many times also the new notation, A : B ∷ C : D, the two notations being used interchangeably. Later there appeared from his pen, in London, three books in one volume, the "Logistica astronomica" (1656), "Doctrina spherica" (1655), and "Doctrina theorica" (1655), each of which uses the notation, A : B ∷ C : D.

The book by the second author is entitled "An Idea of Arithmetick at first designed for the use of the Free Schoole at Thurlow in Suffolk . . . by R. B., Schoolmaster there" (London, 1655). One finds in this text 1 . 6 ∷ 4 . 24, and also A : a ∷ C : c.

It is worthy of notice also, that in a text entitled "Johnsons Arithmetick, in Two Bookes" (second edition, London, 1633), the colon (:) is used to designate a *fraction*. Thus, ¾ is written 3 : 4. If a fraction be considered as an indicated division, then we have here the use of : for division, at a period fifty-one years before Leibniz first employed it for that purpose. However, division dissociated from the idea of a fraction is not designated by any symbol in Johnson's text. In dividing 8976 by 15, he writes the quotient 598 6 : 15.

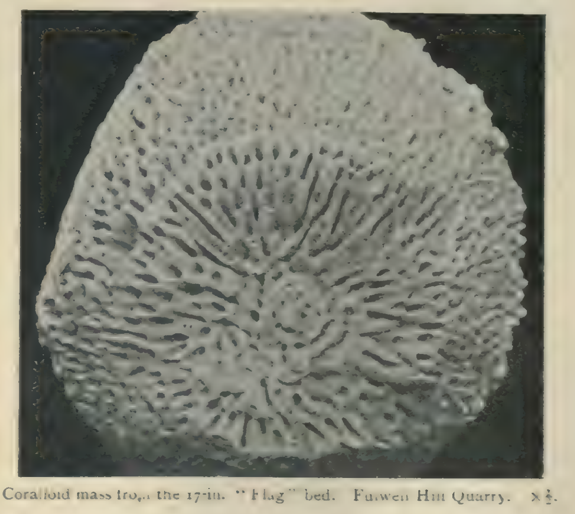
FLORIAN CAJORI.

London, December 23, 1914.

Is "Atikokania lawsoni" a Concretion?

HAS a mistake not been made in Memoir No. 28 of the Geological Survey of Canada? Dr. C. D. Walcott therein describes certain silicified structures in the Steeprock Limestone of Lake Ontario which he names *Atikokania lawsoni*. He considers they represent "a group of organisms related to the sponges," or else corals like the Archæocyathinæ.

He appears to have relied on three of their features: (1) a central cavity; (2) the general form, including an inner and outer wall, with (3) radiating tubes with septæ. Unfortunately they possess "no structural details." I suppose the author was unacquainted with the characters met with in the Magnesian Limestone of Fulwell Hill, Sunderland, where the forms are entirely due to segregation or to osmotic influence. His illustrations have a remarkable resemblance to much seen there in what I designate coralloid—a specimen of which is shown in the accompanying figure.


Coralloid mass from the 17-in. "Flag" bed. Fulwell Hill Quarry. × ½.

These have often solid centres like those in his Fig. 5, plate 1; the bands also resemble the irregular septa in his Atikokania. Without any traces of spicules it seems to me very doubtful indeed that these bodies have any organic origin, especially as it seems clear that changes in rocks after deposition lead sometimes to the formation of tubes. If my conclusions are correct, this in the Fulwell coralloids is certainly a very common development in the almost universal rod formation there. The change appears to be the result of the adherence of small circular groups of rods around a central canal; with so much of such material—there are at least two square miles of it some 130 ft. thick—the cause, whatever it may be, seems unconnected with either erosion, hydration, dolomitisation, metasomatosis, or organic remains.

I have also seen tubes of this kind in a few other calcareous rocks, but the most common banded formation (probably allied to the septæ in Dr. Walcott's specimens) is seen in weathered mortar found in the shady parts of old buildings, especially those situated near the coast. GEORGE ABBOTT.

2 Rusthall Park, Tunbridge Wells, November 18.

WHEN your letter of November 23, 1914, enclosing a note by Mr. George Abbott on the silicified structures described in Memoir No. 28 of the Geological Survey of Canada as *Atikokania lawsoni*, reached me on December 8, I had on my table a copy of NATURE of January 29, 1914, containing the note on "Zonal Structure in Colloids," by Mr. Abbott. Prior to meeting with this article, I did not know of the remarkable structure of the Sunderland Magnesian Limestone, or I should have certainly directed attention to it.

During the past summer I made large collections of supposed algal remains from the pre-Cambrian rocks in the Rocky Mountains of Montana. Some of these appear to be of undoubted organic origin. Others appear to be a combination of algal deposits in connection with concretionary consolidation.

The subject is now under investigation, and in this connection I shall take up the forms that I called Atikokania. With present information I should *not* be inclined to refer the latter to the sponges or to the Archæocyathinæ. CHARLES D. WALCOTT.

Smithsonian Institution, Washington, U.S.A.,
December 9.

A HISTORY OF BRITISH BIRDS.[1]

WE have already noticed the first four parts of this comprehensive publication, and the general scope of the work and the plan on which it is carried out need not be more than briefly referred to here. We now welcome the twelfth and concluding section of the work and the last of its attractive and fascinating pages.

The book claims to be the only existing work which gives an adequate account of the habits of all our species of birds, except those so rare that they cannot be said to have, as British birds, any habits worth describing. These latter are treated shortly at the end of the last volume. It claims also that it brings together from every source, British and foreign, the whole available information on the subject, and presents it in a form interesting alike to the specialist and the general reader. In showing what is known and what has yet to be found out about the habits of our birds, and in laying stress on the scientific problems which underlie the facts, the work stands alone in giving to the serious student of bird-life starting-points for further research. Though not professing to do more than supply summaries of the geographical distribution of all the species, the work claims to give recent information under this head which is not to be found in any other book on British birds.

It would be unjust to the contributors to these volumes if the impression arose that they had been merely content to compile the observations of others. For while it is true that in more than one case contributors to this book have found themselves in the very unsatisfactory position of having to write about species of which they had little personal knowledge, there is much information in the book that is the result of direct personal observation, and much, again, of this information could have been supplied only by the contributors and by no one else. Among them we have only to name the Rev. F. C. R. Jourdain, who, in search of eggs, has travelled over so much of Europe and the adjacent countries, and Mr. William Farren, to show how much valuable original observation the editor has had to draw upon among his various contributors. As the editor points out, too, though the bird-man who has concentrated his attention on a few species

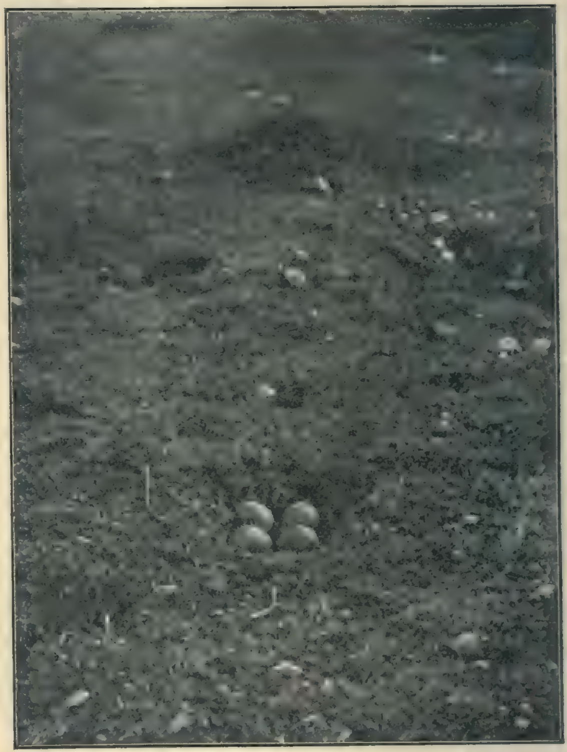


Photo.] [*W. Farren.*
FIG. 1.—Lapwing's nest. From "The British Bird Book."

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[1] "The British Bird Book." Edited by F. B. Kirkman. Sections V—XII. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 10s. 6*d.* net, per section.

—the specialist in field ornithology—cannot afford to ignore the experience of others in his own field, and must to some extent be a compiler if he is to be thorough, it is obvious that he has a great advantage over the non-specialist in that his knowledge enables him to value and select the evidence with a confidence that cannot be felt by one who is dealing with the relatively unfamiliar.

These conditions and circumstances, and what naturally follows from them, doubtless account for the somewhat uneven quality of the various accounts of the different families or groups of birds which go to make up this very readable work. It is pointed out that in a work to which there are several contributors, it becomes necessary to bring into harmony the claim of the individual writer to express himself in the way he thinks best, and the claim of the editor to subordinate individual treatment to the general plan. To strike the just balance between the two is far from easy—perhaps impossible. The tendency in the present work has favoured the individual. The gain has been a vigour and freshness of treatment that are not always conspicuous in works of this kind; the loss a certain weakening of methodical arrangement which is more particularly apparent in the earlier part of the work, owing partly, however, to circumstances that were neither contemplated nor desired, nor, at the time, capable of remedy. The loss, it is hoped, will be practically made good by the completeness of the index. Be this as it may, although some of the articles may be somewhat weak, and perhaps in parts fanciful, we have here, on the whole, a series of excellent life-histories of our birds; many of them written by experienced and accurate naturalists from their personal and recent experience and observations. There are statements to be found with which we do not agree; and it would not be difficult to criticise parts of the book. But it is a great and a novel work; and, if anything, it improved as it went on.

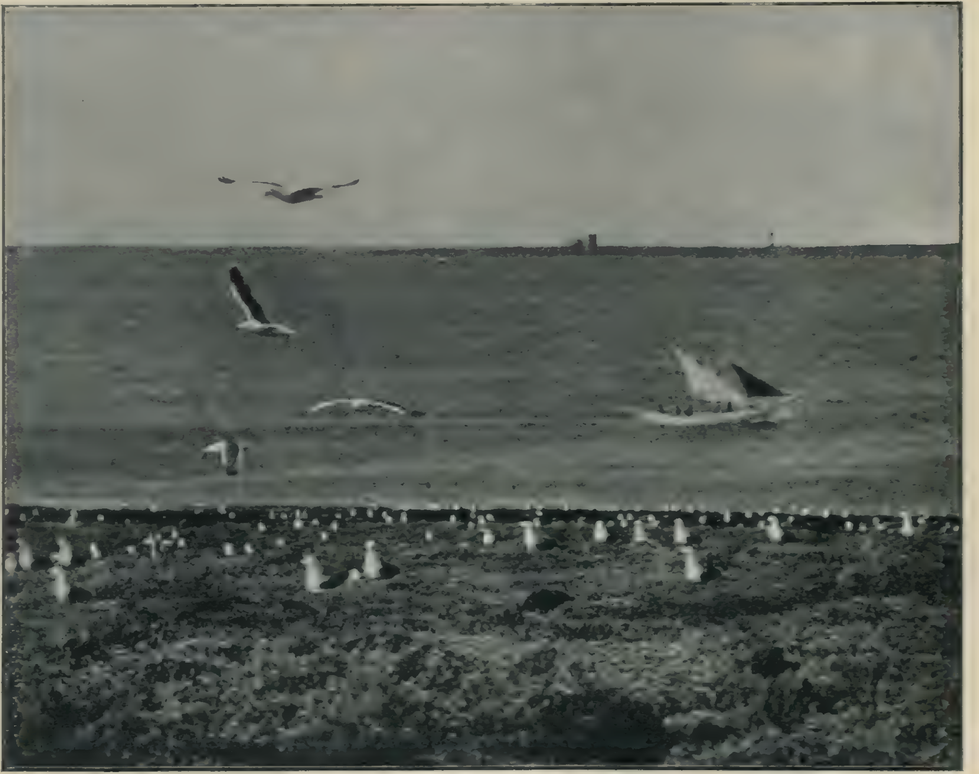


Photo.] [*F. B. Kirkman.*

FIG. 2—Nesting ground of lesser blackbacked-gull (Farne Islands). From "The British Bird Book."

The coloured illustrations have been drawn from life, not from stuffed specimens; in many cases long special journeys have been made to distant localities to study little-known birds for the purpose of this book. Photographs of nests, nesting sites, etc. (two of which are reproduced here), as well as a series of coloured plates of eggs of British birds, are given.

If the scheme of the work is new, that of the larger illustrations is in keeping with it. The coloured plates are not merely figures of the birds, but they also tell part of their life-history. We may instance those of the sand grouse, crested grebe, the arctic tern pursued (as is its wont) by a skua, and the red-legged partridge struck down by a peregrine. Where it is the habit of the bird to congregate, it is so represented, *e.g.* the gannet, of which twenty-seven individuals appear in the plate. Mr. Seaby's delightful coloured studies alone are enough to give everyone interested in our birds an overpowering desire to put these volumes on their book-shelves. Many of them will recall to the naturalist scenes which he has witnessed, but, alas! has not had the power to preserve except in memory. For in their illustration of bird-life no photograph will vie with the coloured drawing of the skilled artist *who really knows his birds.* Apart from the all-importance of correct and delicate colour, the camera undoubtedly does not see things just as the human eye sees them. To name only one, Mr. Seaby's pied flycatchers, as an example of the sort of picture of bird-life we really desire. The female is about to feed the young, the male looking on. Here we have a bit of life-history shown in just the spot in the deeply shaded June woods where the nesting birds will be found—perfect in its facts and details. The birds are alive, the expression in their eyes quite wonderful.

The coloured plates of eggs (some by Mr. Grönvold), carefully prepared, cannot fail to be useful for identification purposes. Since the eggs of the great bustard and the avocet (not to mention the wood sandpiper, only once known to nest in Britain) are figured, we are at a loss to know why that of the black-tailed godwit is omitted. All three birds have ceased to breed with us, but the godwit was the last to survive as a breeding bird, and, moreover, is the most likely of the three to resume that status. There is a useful plate illustrating the down and *nest feathers* found in the nests of the different species of wild duck, the eggs of which are often very much alike. It is only by means of these feathers that the identity of ducks' eggs can be made sure of.

The final section of the work comprises classified notes on the rare British birds (including all species not described in the body of the book), extending to nearly a hundred pages. Chapters on structural characters; migratory movements, by Mr. T. A. Coward; the study of bird behaviour; and bird photography. Also a list of works consulted and a good and full index.

SUPERSTITION AND DISEASE.[1]

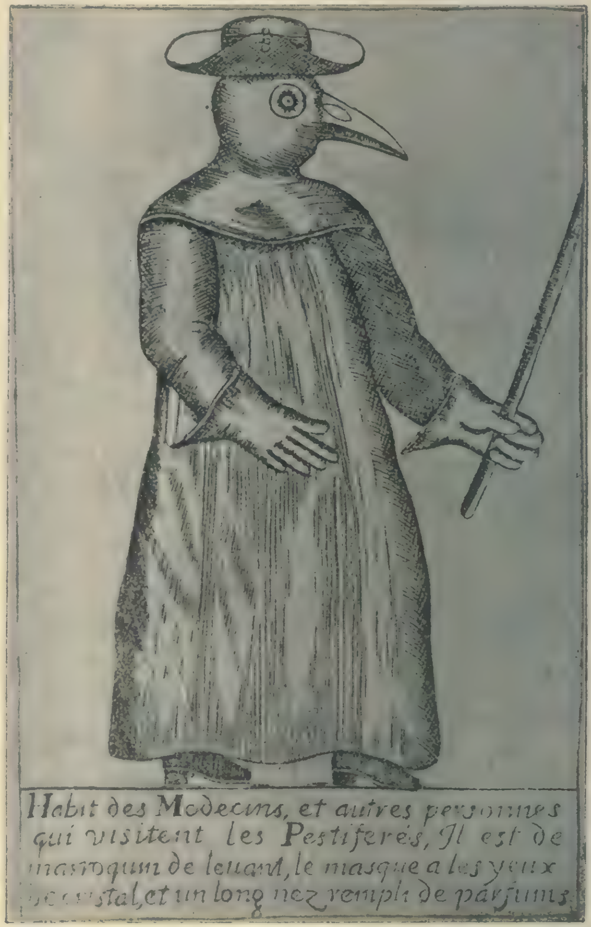
THIS volume represents the Fitzpatrick lectures for 1912 delivered at the Royal College of Physicians. Dr. Crawford has treated his subject as much in its mental and moral aspects as in its physical, and the result is a wise and very interesting book. In a few chapters he gives us a vivid presentment of the long series of epidemics which devastated Europe and the Levant between the days of Moses in Egypt and those of Napoleon at Jaffa. Painting, sculpture, and architecture have all been pressed into the service, and the thirty-one plates in the book testify to the frequency with which the world's great artists have found inspiration in the terrible scenes of a plague-stricken city.

Many writers, too, from Thucydides to Pepys have been laid under contribution, and bear witness to the magnitude of the catastrophes. We read of Rome in the thirteenth century shaken by twelve visitations of plague, each one extending over several years. We read of the Black Death when one-fourth of the entire population of Europe perishes. Half England is wiped out in this pandemic, and towns and villages are stripped of inhabitants.

Sometimes the epidemic runs its course with appalling rapidity. The destruction by plague of Sennacherib's army in one night may be legendary, but there is no reason to doubt that in Byzantium during a four months' visitation the daily mortality often reached the total of ten thousand.

Dr. Crawford directs attention to the identity through the ages of the "portents" of plague. For example, the angel with drawn sword is seen to hover over London in 1665, as over Rome in 590, and over Jerusalem centuries before Christ.

From century to century, too, similar theories of its causation are rife. It is the work of malignant demons; it is sent from heaven in punishment for sin; it is the result of evil magic exercised by man on man; it is engendered in the clouds; it is caused by earthquakes which liberate the poisons from the earth; by dust which irritates the skin; by impure air, or unsuitable food. Of all the speculations, the most mischievous because productive of such hideous cruelty is the surmise that it is caused by water which has been poisoned by our enemies, the Jews—or by our enemies, the Christians.


Habit des Medecins, et autres personnes
qui visitent les Pestiferés, Il est de
marroquin de leuant, le masque a les yeux
de cristal, et un long nez rempli de parfums

Dress of a Marseilles doctor, 1720. [From "Plague and Pestilence in Literature and Art."

Dr. Crawford points out that the contagious character of the disease was recognised by lay observers long before it was accepted by science. The mental myopia which is, he says, apt to afflict science when untempered by letters is indeed apparent in this connection, and it is chastening to professional complacency to note the long list of lay writers from Thucydides onward who accept the truth of contagion from man to man, while the doctors agree in rejecting it.

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[1] "Plague and Pestilence in Literature and Art." By Dr. Raymond Crawford. Pp. viii+222. (Oxford: Clarendon Press, 1914.) Price 12s. 6d net.

The methods of cure vary little throughout the long period with which Dr. Crawford deals. The plague may be stayed by offerings of prayer and sacrifice. In this belief Marcus Curtius hurls himself into the abyss, or Solomon Eagle prays in the streets, naked, and bearing on his head a brazier of burning coals. Or scenic plays are performed with the double purpose of propitiating the angry gods, and of distracting men's minds. It is true that Livy notes when this treatment is first applied:—"The plays neither distract men's minds from religious awe, nor their bodies from disease"; but, for all that, the practice continues far down into the Middle Ages, when mystery and miracle plays are used as instruments of intercession with the saints.

Among the more material methods of treatment the kindling of huge fires is ordered by Hippocrates by way of curing the "distempered" atmosphere, which the Father of Medicine conceived to be the chief cause of disease in man. His example is scrupulously followed in the plague of London in 1666, and in that of Marseilles in 1720. Some physicians throughout the centuries advocate temperance in all things—especially in food and drink; others, again, see safety in intemperance. Dr. Nathaniel Hodges, for instance, holds firm belief in double doses of sack whenever exposure to infection is inevitable.

But for the most part medicine confesses herself helpless, and owns that the only prophylactic treatment likely to be successful is instant flight—tempered, perhaps, by purgatives or by "Armenian bole." This is the prescription of Galen, and it is only too faithfully adopted by himself and by the majority of physicians in plague-times after his day.

Many names, however, in the arenas of both medicine and religion shine out with radiance across this sombre background of ignorance and error. One of the most noteworthy is that of the intrepid Gregorius, who dissects three dead bodies in the vain hope of finding the cause of the scourge.

Science does move, moreover, even though it be but slowly, slowly. Little by little a code of sanitary precautions grows up, and superstition wanes as the true nature of the disease is recognised, and the right precautions adopted. Plague, exorcised by knowledge, vanishes almost entirely from western Europe before the end of the eighteenth century.

Dr. Crawford is, as we have indicated, specially interested in the beliefs and the behaviour of man under the stress and strain of plague-epidemics. In the history of the disease he finds striking evidence of the inherent tendency of the human mind to revert to savage instincts in face of crushing calamity.

But that, after all, is only one aspect of our more than Janus-faced mentality to which Dr. Crawford is, perhaps, a little less than kind. For, turned in another direction, it is our mentality which leads us away from the panics, despairs, and barbarities of ignorance, into the sanity and efficiency of exact knowledge.

E. H. MARTIN.

HISTORY AND ETHNOLOGY OF ASSAM.[1]

THIS book is intended to supply a popular account of northern Assam and its borderland, the details of which are scattered through a wide and not easily accessible literature. The sword of the gallant author is mightier than his pen, and it is a subject of regret that the manuscript was not revised by someone with a keener sense of style. In dealing with the more obscure questions of archæology and ethnology he does not profess to write as a specialist, and if the book had been confined to an account of the savage tribes of the borderland and their relations with the British Government, the local experience of the author would have found ampler scope. With these reservations the book is an interesting account of a country of which, be it said to our shame, the average Englishman knows little.

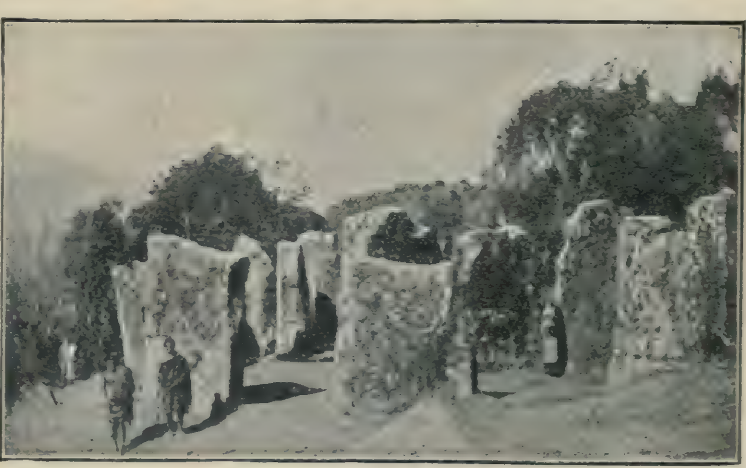

FIG. 1.—The remarkable "Stonehenge" at Togwema, Naga Hills. From "History of Upper Assam, Upper Burmah, and North-Eastern Frontier."

The best part of the book is the account of the tribes. Much has recently been done to extend our knowledge of these races by the admirable series of tribal monographs now in process of publication by the Government of Assam. Of these and of the valuable "Gazetteer of Upper Burma and the Shan States," by Sir J. G. Scott and Mr. J. P. Hardiman, Colonel Shakespear has made much use. But his own experiences have enabled him to add interesting material, and the large collection of photographs and drawings adds to the value of the book. It has passed the censor attached to the Headquarters staff in India, and it is creditable to that department that they have not suppressed the outspoken criticisms on our methods in the past of dealing with these troublesome neighbours. We have been too prone to delay action for the punishment of raids, to impose inadequate penalties on the guilty tribes, to use large and expensive expeditions to effect what might have been, and has been, done by smaller detachments. Hence, we have met with many regrettable incidents which by prescience and better management might have been avoided.

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[1] "History of Upper Assam, Upper Burmah and North-Eastern Frontier." By Col. L. W. Shakespear. Pp. xix+272. (London: Macmillan and Co., Ltd., 1914.) Price, 10s. net.

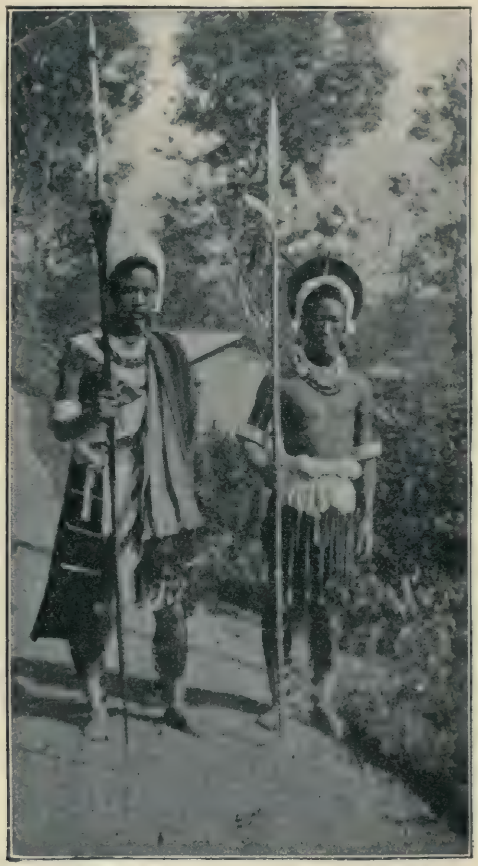

FIG. 2.—Angāmi Nagas. From "History of Upper Assam, Upper Burmah, and North-Eastern Frontier."

The publication of the book is timely because it impresses the need of a firm policy on this frontier, particularly as China is beginning to show her power. If the new Republic succeeds in organising an army capable of meeting disciplined troops we may have trouble before us. To meet this emergency the extension of our railway system to the strategical points on the frontier is an obvious necessity.

COLLOIDAL CHEMISTRY IN RELATION TO INDUSTRIES.[1]

II.

PRACTICALLY the only inorganic colloidal preparation made on a large scale at present is the colloidal graphite manufactured by Acheson and used as a lubricant under the name of "Aquadag." Colloidal tungsten was at one time employed in the manufacture of squirted filaments for incandescent lamps, but these have been superseded by drawn wire. The use of colloidal sulphur as spray for hops and vines has been patented and seems likely to be more efficacious than the coarser suspensions of flowers or milk of sulphur.

Of far greater technical importance, however, than these colloidal preparations of inorganic substances are the bodies which, to the layman, are exclusively suggested by the terms "Colloids" or the colloids of Graham. This class comprises such important constituents of organic raw materials as albumen, hide substance, starch, and cellulose; also the various derivatives of the latter, india rubber, gutta percha, and, finally, many manufactured products, among which glue and gelatin may be mentioned as typical. These various substances naturally exhibit a somewhat bewildering variety of individual behaviours, and it is therefore impossible to do more than refer to some properties they possess in common.

Most of them in contact with water—or, in the case of india rubber and nitrocellulose, in contact with certain organic solvents—exhibit the phenomenon of swelling, *i.e.* they imbibe the liquid with increase in volume. The process may either come to an end without solution or dispersion, as with cellulose, or it may proceed as far as the latter either at ordinary or higher temperature, as with albumen and gelatin respectively. This swelling is obviously an inevitable concomitant or antecedent of any treatment with liquids, and therefore of importance in processes differing as widely as tanning and malting. It is well known empirically that the amount of water taken up is affected by even small concentrations of acid, alkali, and neutral salts. The important fact brought out by colloidal research is that this action, particularly in the case of neutral salts, is in no sense chemical, since it is the same on substances differing as widely as gelatin and agar. This knowledge has already been of great value in elucidating the *rationale* of many empirical processes, and its systematic application is likely to be far-reaching. Particularly interesting is the effect of iodides and thiocyanates, which promote the absorption of water to such an extent that, for instance, gelatin dissolves in *cold* solutions of such salts, and that cellulose (as has been shown by v. Weimarn) can be dissolved in hot solutions of calcium iodide or thiocyanate.

A further general rule is that solutions of all these bodies, whatever their nature or that of the solvent, exhibit two peculiarities: the physical properties do not depend simply on the concentration, but on the whole previous treatment, especially as regards temperature, and they are not in any event stable, but vary with the age of the solution, although no chemical change whatever may be demonstrable. It is therefore of the utmost importance that a solution, such as the cellulose or nitrocellulose solutions used in making artificial silk, should possess identical properties at a given moment, and research has shown that the most sensitive and most easily measured "indicator" constant is the viscosity. Viscosity measurements accordingly form a recognised means of control in these and other industries. The theoretical study of viscosity is also gradually throwing light on the mechanism of the changes which colloidal solutions undergo in ageing.

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[1] Continued from p. 422.

A very general property of finely divided matter, and therefore of colloids *par excellence*, is the power of taking dissolved substances out of solution. This phenomenon, so far as it consists in a concentration of such dissolved substance on the surface of the colloid, is called adsorption, and is of the greatest importance in nature and in the arts. The use of Fuller's earth and of gelatin or isinglass for decolouring and clarifying liquids is one of the familiar applications: other instances are so numerous that the difficulty is one of selection. Thus the processes of dyeing and of tanning begin with adsorption, which may be followed by chemical reaction or by diffusion of the substance, concentrated in the first instance on the surface, into the body of the fibre. According to the personal bias of investigators each of the factors involved has been credited with preponderating importance, and it will require much patient work to settle their relative share in processes so complicated. Adsorption, as distinct from chemical combination, has also been advanced as the explanation of certain peculiarities in the vulcanisation of rubber, and forms a subject of rather acute controversy. The adsorptive action of various constituents of the soil on the salts necessary to plant life, a line of investigation first pursued by van Bemmelen, is gradually becoming clear, and light is thereby thrown on a subject of extraordinary intricacy. The so-called humus substances, in particular, have received attention recently, and there seems to be sound evidence in favour of the view that their effect is largely due to their adsorbent action rather than to their somewhat indefinite acid character. In photographic chemistry the proof that the photohaloids, *i.e.* the coloured products obtained by exposing certain forms of silver halogen salts to light, are adsorption compounds of silver and silver salt, has been established experimentally by preparing these products from silver salt and colloidal silver. Incidentally, it may be remarked that the connection between degree of dispersity, mentioned in the last article, and colour has provided the explanation for the great range of shades of the silver image which can be obtained by varying the exposure and the concentration of the developer.

We have so far considered colloids chiefly in a state of suspension or solution, and have now to refer briefly to the equally important "gel" condition, *i.e.* the more or less solid form they assume when solutions of sufficient concentration are allowed to set by cooling, *e.g.* gelatin and agar, or when the solvent is removed by some means. The most familiar example is the gelatin jelly. These gels possess a number of properties of great technical importance. Many of them retain their cohesion and elastic properties when the greatest part of the solvent is removed, so as to yield elastic filaments or films; cellulose and several of its derivatives are thus used in the manufacture of artificial silk and of photographic films. The elastic properties can be varied considerably by the addition of other soluble substances to the solvent: one of the most important instances is celluloid, consisting of nitrocellulose and camphor or various related bodies. Another important feature of certain gels is that of being rendered insoluble and also incapable of absorbing water by various agents: thus casein treated with formaldehyde becomes a very stable plasmic mass, used industrially as "galalith," while gelatin, to which a small amount of a bichromate has been added, becomes insoluble on exposure to light—a property utilised in the "carbon" process of photographic printing and other methods of photographic reproduction.

Since gels contain very large percentages of liquid the diffusion of dissolved substances in them is very little impeded, as was known already to Graham. Solutions of two reacting substances may, therefore, easily be brought into contact in a gel, and reactions carried out in these conditions exhibit a number of very striking and important peculiarities, of which space permits us to mention only one. By a suitable choice of concentrations the reaction may be slowed and may be arrested at an intermediate stage, which in aqueous solutions would be quite transitory. Perhaps the most striking instance is the extremely sensitive silver bromide of the photographic dry plate, which cannot be produced at all in aqueous solution. It is very probable that this effect of gels may become of technical importance in many other directions, and it deserves careful consideration.

Although the survey here given has necessarily been very brief and incomplete, it is probably adequate to show in how many directions industry is likely to profit by research in colloidal chemistry. To sum up briefly, the latter has demonstrated the bearing on chemical processes and their results of a number of factors which are in no sense of the word "chemical," such as the degree of dispersity; the electrical properties of finely divided matter and the possibility of modifying them by the reaction of the medium; the effect of the latter on such universally important phenomena as swelling of organic substances and on their elastic properties and, finally, the innumerable manifestations of adsorption. The recognition of all these factors will naturally be a somewhat arduous task, but will furnish at the very least a new method of attacking problems which cannot be solved by chemistry—in its narrower sense—alone. E. HATSCHEK.

PROF. J. W. HITTORF.

THE death of Johann Wilhelm Hittorf, at the age of ninety years, removes an eminent and honoured leader from the ranks of German physicists. Born and brought up in Bonn, Hittorf devoted himself to the study of mathematics and natural science at the Universities of Bonn and Berlin, and became Doctor of Philosophy in 1846. Shortly afterwards he attached himself, as privatdocent, to the Academy (later the University) of Münster in Westphalia, the institution with which he was to be associated during his lifetime. Appointed "ausserordentlicher" professor in 1852, Hittorf became full professor of physics and chemistry four years later, and this post he held till 1879. On the reorganisation of the institution in that year, the chair of physics and chemistry was divided, and Hittorf continued as director of the physical laboratories until serious illness compelled him, in 1889, to seek relief from active teaching work. With rest came recovery and renewed activity, to such good purpose that between his seventieth and eightieth years Hittorf published some half-dozen memoirs. He died on November 28 last, as professor emeritus of the University of Münster, full of years and honour.

Hittorf's investigations dealt with a number of problems on the borderland of physics and chemistry, and the results are embodied in about thirty communications to scientific journals. In appraising this output of original work, it must be borne in mind that the earlier researches were carried on under serious disadvantages in respect of laboratory equipment, and that he himself was personally responsible for all the experimental work described in these memoirs.

Some of the first researches were concerned with the allotropy of selenium and phosphorus, and the discovery of the so-called "metallic" variety of the latter element was made by Hittorf. This work, however, is quite overshadowed by the remarkable series of investigations (published 1853–9) on the migration of the ions during electrolysis. Whilst Faraday had studied mainly the nature and the quantity of the substances produced at the electrodes by electrolytic decomposition, Hittorf investigated the more subtle changes of concentration that take place in the electrolyte itself. From these concentration changes, the relative rates at which the ions of an electrolyte move during the passage of a current, and their relative share in the transport of the electricity, were deduced.

This work met with practically no recognition from Hittorf's contemporaries, and indeed was vigorously attacked by the leading German physicists of the time. Twenty years later the significance of these investigations began to be appreciated, and fortunately Hittorf lived to see his great work accepted as a fundamental part of the science of electrochemistry.

A prominent place among Hittorf's researches must be assigned also to investigations, carried out at the suggestion of his master Plücker, on the spectra of ignited gases and vapours. The memoir embodying this work, which was published in the Philosophical Transactions for 1865, deals with the plurality of spectra, and shows, more especially for the case of nitrogen, that the same substance can give two different spectra. Hittorf's association with Plücker may be further traced in a series of important papers on the passage of electricity through gases; the foundation of what is known regarding kathode rays, discovered by Plücker in 1859, was laid in these investigations.

The remarkable activity of Hittorf's later years, already referred to, was shown chiefly in a study of the passivity of metals, more especially chromium; it was found that this phenomenon cannot be attributed to the presence of a film of oxide on the surface of the metal. It is a striking fact that in his last published memoirs Hittorf returns to the transport of electricity in electrolytes, the field of research in which he laboured fifty years before, and with which his name will be inseparably associated.

J. C. P.

DR. N. C. DUNÉR.

THE death of Nils Christoffer Dunér has deprived Sweden of one of her most distinguished men of science, and astronomy of an active and devoted student. Born on May 21, 1839, Dunér entered the University of Lund in 1855, and took his doctor's degree in 1862. He became a member of the staff of the Lund Observatory in 1864, and occupied that position until his appointment, in 1888, as Professor in the University and Director of the Observatory of Upsala. He died at Stockholm on November 10, after a brief illness following his return from a journey to observe the solar eclipse of last August.

Dunér made notable contributions to many departments of astronomy, and his name will be especially remembered in connection with his work on double stars, variable stars, the spectra of red stars, and the investigation of the sun's rotation by the spectroscopic method. His work on double stars during the years 1867 to 1875 at once placed him in the front rank of double-star observers and computers.

Several variable stars were discovered or investigated by Dunér. Two of them—Y Cygni and Z Herculis—have proved to be of exceptional interest. Dunér not only found that the light-changes of these stars could be completely explained by supposing them to be eclipsing variables of the Algol type, with the difference that both components are bright, but was able to determine the elements and dimensions of the two systems.

In 1878 Dunér turned his attention to stellar spectra, and with only a 10-inch refractor at his disposal, courageously entered upon a systematic survey of the red stars. His classical memoir, "Sur les étoiles à spectres de la troisième classe," 1884, gives details of his eminently successful observations of the spectra of 352 stars. Further observations were made with the Upsala 36 cm. refractor in 1893. The interest of such observations is now largely discounted by the entry of the giant telescopes and spectrographs of America into this field of research, but Dunér rightly considered that comparative observations of a large number of stars by a single observer might have a special value.

Another important investigation by Dunér was that on the sun's rotation, carried out at Lund, and later at Upsala, with a powerful grating spectroscope which he designed for this purpose. His memoir, "Recherches sur la Rotation du Soleil" (1891), is a model report on a scientific investigation, and a lasting tribute to the skill of its author. The observations were extended to solar latitude 70°, and showed that the polar retardation indicated by spots was continued far beyond the sun-spot zones.

Dunér was an inspiring teacher, and his amiability and self-sacrificing devotion to their interests gained for him the affection and gratitude of his pupils and fellow-workers. His scientific achievements brought him many distinctions, among which may be mentioned the award of the Rumford medal by the Royal Society in 1892, and election as an Associate of the Royal Astronomical Society in 1889.

NOTES.

INQUIRIES which reach us from time to time suggest that many people would find it a convenience to be able to examine books received from publishers abroad and reviewed in NATURE. These volumes are usually not readily accessible, and often the only copies existing in this country are the few sent to scientific journals for review. We have therefore made arrangements to retain at NATURE office, St. Martin's Street, W.C., for a period of six months after the issues in which the reviews have appeared, all volumes published in countries outside the United Kingdom. Every volume from abroad reviewed in our columns will thus be on view freely to anyone who cares to call to see it. This arrangement will begin with our first issue in the New Year, and we believe that many men of science will welcome the opportunity which it will afford them of inspecting American and foreign books of which reviews have been printed in NATURE.

AFTER a long period of service in that capacity, Mr. W. L. Distant is resigning the editorship of the *Zoologist*.

THE Rome correspondent of the *Times* reports that among the Italian Senators who are to be nominated on New Year's Day is Signor Marconi.

THE death is announced at Los Angeles, in his seventy-sixth year, of Dr. John Muir, member of the Washington Academy of Sciences, and distinguished as an explorer and naturalist, as well as by his work for many years in the cause of forest preservation.

IT is announced in *Science* that in the will of the late Miss Dessie Greer, the American Museum of Natural History is designated as the ultimate beneficiary of a fund of 18,000*l.* By the will of the late Mr. W. Endicott, of Boston, a bequest of 5000*l.* for cancer research is made to Harvard University.

THE death is announced, at sixty-four years of age, of Sir Robert Simon, professor of therapeutics in the University of Birmingham since 1910, and author of a book on "Disease of Brass Workers" and other works; also of Mr. D. Balfour, member of the Institution of Civil Engineers, and a fellow of the Geological and the Royal Meteorological Societies.

WE regret to announce the death, in his seventy-second year, of Dr. Leon Lereboullet, president of the French Medical Association, and associate member of the Academy of Medicine. An obituary notice in the *British Medical Journal* points out that he collaborated with Dechambre on the *Gazette Hebdomadaire de Chirurgie*, and was editor of the "Dictionnaire Encyclopédique des Sciences Médicales." He was also the author of several works on medicine, and of a series of articles on the health service which attracted the attention of Jules Ferry and other leading statesmen.

THE Governor of Bombay unveiled on November 30 a simple marble memorial tablet in Bombay Cathedral to Lieutenant Bowers, Royal Indian Marine, who lost his life with Captain Scott and his comrades in the Antarctic. We learn from the *Times* that the memorial at Finse, in Norway, in honour of Captain Scott and his companions was unveiled on December 28 by Dr. Skattum, vice-president of the Norwegian Geographical Society. The memorial has taken the form of a monument about 20 ft. high bearing the names of the explorers—Captain R. F. Scott, Dr. Wilson, Captain L. E. G. Oates, Lieutenant H. R. Bowers, and Petty Officer Evans—and an inscription reading:—"Erected by Norwegians in honour of Antarctic research and heroic courage."

A MEETING of the Imperial Advisory Council of the Institute of Industry and Commerce was held on December 22 at the offices of the institute on Aldwych Site, Strand, for the purpose of considering, among other matters, the best means of bringing about the standardisation of company law throughout Great Britain, the Dominions and Colonies in order to facilitate commerce within the Empire. The council decided that a memorandum should be drawn up by the institute after consulting with the leading specialised trade organisations, and that this memorandum be submitted to the Agents General of the Dominions and Colonies for submission to their respective Governments. The policy of the institute is to develop a set of satisfactory working conditions within the Empire in which industry can operate, and if this is accomplished satisfactorily a considerable increase of trade should follow.

A CENTRAL NEWS telegram from Amsterdam, published in the *Times* of December 21, announced that Prof. Otto Sackur was blown to pieces by an explosion which occurred in the laboratory of the Kaiser-Wilhelm Institute at Dahlem, near Berlin, where experiments in high explosives were being conducted. The Kaiser-Wilhelm Institute was founded in 1911 by the Kaiser-Wilhelm Association for the Advancement of Science, and the first volume of results of researches issued by it was described in NATURE of May 28 (vol. xciii., p. 322). Prof. Sackur was one of the ablest of the younger physical chemists in Germany. A pupil of Richard Abegg, he became a Privat-dozent in the University of Breslau, and on Abegg's appointment to the Technische Hochschule there, succeeded him as extraordinary professor in the University. He later received an appointment in the Kaiser-Wilhelm Institute. Sackur was more distinguished as a theorist than as a practical worker. His papers cover a wide range, and are characterised by considerable independence of thought. In 1912 he published a "Lehrbuch der Thermochemie und Thermodynamik," which is an admirable modern introduction to the subject, and is, we understand, being translated into English.

THE Duke of Bedford presided at the general monthly meeting of the Zoological Society on December 23, 1914; twenty-two new fellows were elected, the honorary membership of the society was conferred on Field-Marshal Earl Kitchener of Khartum, and eight new names were added to the list of corresponding members. During November fifty additions were made to the menagerie, of which forty-two were presented; among the latter particular interest attaches to a pair of South African elands presented by Mr. A. H. Wingfield, of Ampthill House. During the same month the number of visitors to the gardens was 26,403, or 15,166 fewer than in November, 1913. From January 1 to November 30 the total number of visitors was 1,037,929, representing a decrease of 90,225, as compared with the corresponding period in 1913.

IN a letter to the *Times* of December 26, and in an article in the *Strand Magazine* for January, 1915, Sir E. Ray Lankester disputes the idea that Germans are entitled to special pre-eminence in the domain of physical sciences. On the contrary, with the exception of the work in spectrum analysis in the middle portion of last century, their claims to original discoveries of importance, more especially during the reign of the present Kaiser, are comparatively insignificant. Their real line of success lies in their capacity for adopting and developing the discoveries made in other countries for their own interest and benefit, more especially when large profits are to be made, as in the case of the artificial synthesis of indigo and other organic products, by such means. In their voluminous treatises on the history of science published during the last forty years they have in many instances deliberately ignored the claims of investigators in other countries to discoveries and ideas upon which their own work is based.

THE Committees on Food and Hygiene of the Paris Academy of Sciences have presented reports dealing with the conservation of cattle during the war and with the alcohol question. In view of the meat supply required for the troops and the necessity of reserving the best animals for reproduction, it is recommended that all young animals and calves should be preserved and that importations of meat from Australia, New Zealand, the Argentine Republic, and the French colonies should be encouraged. It is also suggested that animals should be killed in the place where they were raised, as the transport of live cattle is attended with many disadvantages. The installation of large cold storage depôts is recommended. Recommendations were also made with regard to the consumption of alcohol. It is proposed that the number of places open for the sale of alcoholic drinks should be limited, that absinthe and similar liqueurs should be absolutely prohibited, and that the privilege of the *bouilleurs de cru* should be suppressed. These conclusions were unanimously adopted by the academy, and forwarded to the Government.

A NOTICE recently appeared in *Science* that the late Dr. Albert Günther's collection of pamphlets relating to fishes, amphibia, and reptiles has been secured by the Carnegie Museum at Pittsburgh. As a matter of fact, some years have elapsed since Dr. Günther, finding that through failing eyesight he could no longer make full use of this portion of his scientific library, and being naturally loathe to break up an unrivalled collection of separate papers and monographs gathered from the scientific periodicals of the eighteenth and nineteenth centuries, and knowing of no purchaser in this country, determined to sell the collection as a whole to Prof. C. H. Eigenmann, of Indiana University, who also held the post of curator of ichthyology in the Carnegie Museum. The collection shipped to America in August, 1910, comprised nearly 7000 octavo and 600 quarto and folio pamphlets, by some 1200 authors. The possession of so complete a literature in so compact a form enabled Dr. Günther to identify and describe collections of fish at home without always having to visit public libraries. He often said that so complete a series of the smaller monographs on the ichthyology and herpetology of the time would probably never be accumulated again. May their value be as great in the New world as it has been in the Old!

As announced with regret last week, Mr. A. R. Hunt, who was well known in the British geological world, died at his residence, Southwood, Torquay, on December 19, aged seventy-one years. Son of a chief of an old firm of wine shippers, he was born and lived his earliest years in Portugal. After taking his M.A. degree at Trinity College, Cambridge, he read for the Bar, and was enrolled a barrister of the Inner Temple, not, however, to follow the profession. His family settling in Torquay, brought him into association with Pengelly, and the stirring revelations of

Kent's Cavern, and under these influences he found his interests and attention directed towards natural science. In 1872 he was elected a member of the Torquay Natural History Society, and for the rest of his life he gave that institution his enthusiastic support, serving for long on the committee and as president for the years 1879–81. He was closely associated with the Kent's Cavern explorations, and his familiarity with details and parts rendered him the best fitted man then living to conduct the Geologist's Association through the cavern on its visit to Torquay in 1901. Mr. Hunt's fondness for sailing led to his striking out a line of investigation that put his yacht to scientific use by exploring the inshore sea bottom with dredges and studying the action of shore waves and currents. This he followed up by constructing experimental tanks, and his researches were recognised by practical engineers dealing with the problems. His literary contributions to science are mainly included in the Transactions of the Devonshire Association, which contain thirty papers by him. More communications in number are contained in the *Geological Magazine,* and he also contributed to the Linnean Society's Journal.

M. ROMAIN ROLLAND's eloquent appeal now appears in pamphlet form—"Above the Battlefield" (Cambridge: Bowes and Bowes; price 6*d.* net). Its main thesis should be interesting to scientific readers, since it is an indictment of European leaders of thought for their attitude to war in general and the present war in particular. War, he assumes~~, is~~ a catastrophic calamity to civilisation and the race; "it is always the octopus sucking the best blood of Europe"; "is there no end to this bloody and puerile sport, in which the partners change about from century to century—no end, until the whole of humanity is exhausted thereby?" Many who might protest are apt to listen to "the old refrain of the herd that makes a god of its feebleness . . . 'the fatality of war is stronger than our wills.'" But "there is no fatality! The only fatality is what we desire; and, more often, too, what we do not desire enough." Leaders of thought, guardians of the pillars of knowledge which support the fabric of culture, "did not desire war. . . . What then did they do to prevent it? What are they doing to put an end to it?" Some are passive, but the majority are active, "stirring up the bonfire, each one bringing his faggot." In this "epidemic of homicidal fury . . . all the forces of the spirit, of reason, of faith, of poetry, and of science, all have placed themselves at the disposal of the armies in every State. There is not one amongst the leaders of thought in each country who does not proclaim with conviction that the cause of his people is the cause of God, the cause of liberty, and of human progress. And I, too, proclaim it."

THE great photographic collections of the National Geographic Society of Washington have again been utilised for a valuable topical issue of the *National Geographic Magazine* for November, which is occupied by a paper under the title of "Young Russia—The Land of Unlimited Possibilities," by Mr. G. H. Grosvenor. The sketch of Russian history, ethnology, geography, and industrial resources is slight, but pleasantly written. The feature of the number is one hundred admirable photographs, of which seventeen are in colour, which represent various phases of city and village types, religion, art, and scenery, with groups of the many races included in the empire.

OF the two chief articles in the December issue of the *American Naturalist,* one, by Prof. J. H. Morgan, relates to the failure to produce mutations in Drosophila by means of ether, while the other, by Prof. J. S. Dexter, is devoted to the analysis of a case of continuous variation in the same genus.

A THIRD contribution to the account of the Long Island fauna and flora, now in course of publication in the Science Bulletin of the Brooklyn Institute, forms the contents of vol. ii., No. 3, of that serial. In this part Dr. F. Overton treats of the frogs and toads, which include ten species, referable to five genera and four families.

THE December number of the *Irish Naturalist* is a very thin one; containing, in addition to notes, reviews, etc., only an article by Mr. E. M. Barrington on the migration of wrens, in which it is shown that numbers of these apparently poor flyers regularly cross the Channel twice a year. The fact being established that the species is a constant migrant leads the author to ask how it comes about that local races have been established in St. Kilda and the Faröes.

Wild Life continues to appear regularly, albeit with a certain reduction in the number of pages, despite the fact that both the editor, Mr. Douglas English, and his collaborator, Mr. W. R. Knight, are serving their King and country, the former as a subaltern in the 1st Surrey Rifles, and the latter as a private in the 1st Batt. H.A.C. In the December issue Mr. Russell Roberts concludes his realistic account of the black rhinoceros; among bird-photographs the most striking is one of a flock of black-headed gulls on the wing, by Mr. H. B. Macpherson.

FOR some time past, as we learn from the report of the council for 1913–14, the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne has been endeavouring to raise a sum of 25,000*l.*, to form an endowment for the upkeep of the Hancock Museum, which is at present a heavy drain on the general fund. Between 3000*l.* and 4000*l.* (including 1000*l.* from Lord Joicey, the president) had been raised, when the outbreak of the war put a stop to the project, at any rate for the present. The most important addition to the museum during the period under review is a magnificent collection of tropical and subtropical butterflies, made by Dr. Eltringham, with special reference to mimicry. A part of this series has been placed on exhibition, and the rest retained in the original cabinets.

To the first half of the Bergens Museum *Aarbok* for 1914–15 Dr. A. Brinkmann communicates the description of a new genus and species of nemertine annelids, based on a male and female dredged in May, 1914, in the North Sea, at a depth of between 1000 and 1200 metres. The new genus belongs to the family Drepanophoridæ, but is peculiar in the circumstance that the rhynchocœlom and the œsophagus open by a common aperture, this feature being recorded in the name Uniporus. The typical *U. hyalinus* is characterised by the total absence of pigment; but in two other members of the genus, one of which was described in 1901 as *Drepanophorus borealis*, the upper surface is well pigmented. The paper concludes with remarks on the affinities and systematic position of the Drepanophoridæ. In another article Mr. B. Tyvold discusses the structure and relations of the parasitic "zoophytes" of the genus Sphyrion, which are found on the fins of lumpsuckers and gurnards, and, although described by Cuvier, have hitherto remained a puzzle to naturalists. It is now decided that their true position is in the family Chondracanthidæ. Whaling at Durban and Saldanha Bay and the various species of whales taken there, form the subject of a third article, by Mr. O. Olsen, who recently described a new species of finwhale from these waters.

It is not surprising that the presidential address of Mr. A. D. Hall to the Agricultural Section of the British Association in Australia has excited considerable interest in the Colonies. The *Agricultural News* (Barbadoes) of November 21 discusses the problems of bringing into cultivation land hitherto allowed to run to waste, in its bearings on West Indian agriculture and conditions. Two phases of winning new land are in progress simultaneously in the West Indian islands—the clearing of fertile soils as yet untilled and the reclaiming of land hitherto regarded as unprofitable to farm. Efforts are also being made to regenerate areas once under cultivation, which have been robbed of their fertility by defective methods of farming. Since loss of water from the soil surface is one of the most important factors in determining fertility under tropical conditions, any methods of reducing this loss have especial significance. Mr. Hall suggests that evaporation can be checked by the provision of screens or hedges that will break the sweep of the wind across the land. Screens of this kind have long been used in the islands to protect such crops as cacao and limes from the persistent sweep of the trade winds, but their use for the conservation of moisture in the soil has received little consideration, and experiments in this direction might profitably be made.

A "Note on the preparation of Indian forest floras and descriptive lists," issued as Forest Bulletin, No. 23 (Calcutta, 1914), by Mr. R. S. Hole, will be found interesting and useful to botanists generally as well as to those concerned with forestry. The author emphasises the importance of taking a comprehensive view of the entire forest vegetation instead of confining attention to the large timber trees, and points out that numerous minor products, some of them of considerable value, are obtained in India from trees and shrubs as yet unidentified, besides the revenue obtainable from insignificant herbs and grasses which form the forest undergrowth or occur in open places in the forest areas. His paper is intended as a first step towards the preparation of simplified floras and descriptive lists and schedules suitable for officials who cannot be expected to have the leisure or the botanical knowledge necessary for the successful identification of species by the floras now in existence. He draws a sharp distinction between the scope and function of a flora and a descriptive list respectively, and gives a summary of the information which it is proposed to include in the latter, together with an admirably planned schedule which includes the ecological as well as systematic characters.

In a valuable paper on the development of the Trinidad oilfields, contributed to the last meeting of the Institution of Petroleum Technologists, Prof. J. Cadman traced briefly but clearly the history of this little-known oilfield, which properly commences, as the paper shows, with the prospecting operations of Mr. Randolph Rust at Guayaguayare in 1902. The mere fact that within thirteen years this oilfield has produced more than seventy-two million gallons of oil, and that the annual output is already more than twenty-two million gallons, in quite sufficient evidence that this field has attained a position of decided importance amongst the sources of supply of petroleum of the British Empire. As Prof. Cadman points out, it is not yet possible to predict what the life of the wells is likely to be, but so far there seems to be no good reason to fear any abnormally rapid rate of exhaustion of the oilfield. There are numerous interesting problems, both technical and geological, presented by this field, which is remarkable for the high pressures existing in the oil-sands and for the considerable proportion of sand carried up by the crude oil. The author has shown how these difficulties have hindered the more rapid development of the oilfield, and gives an interesting account of the methods used to overcome them.

The *Philippine Journal of Science* for June last (vol. ix., sec. A., No. 3) contains an interesting account of an occurrence of iron ore in the province of Bulacan, Island of Luzon, as also of a somewhat special industry of iron smelting that has been developed therefrom. The ores consist of magnetite and hematite, and these are smelted by the natives in small blast furnaces, the iron produced being cast direct into moulds for the production of ploughshares and ploughpoints. The furnaces are built of soft clay bricks set in clay, and cased with bamboos, and are about 7 ft. 6 in. in height, and 5 ft. in external diameter; the inner cavity is 5 ft. 9 in. deep, and is conical, tapering from 40 in. at the top to 20 in. at the bottom. It is fitted with a single clay tuyere, and is blown with the usual Chinese double-acting hand-blower, made from a hollow tree trunk, and fitted with a wooden piston packed with feathers; the blower is 11 ft. 6 in. long and 14 in. in diameter. The furnace is charged with ore and charcoal at intervals, an average charge consisting of 55 lb. of ore and 95 lb. of charcoal; no flux is used. Such a furnace produces about 5 cwt. of castings daily, the iron being a hard white iron, low in silicon, but containing a fair percentage of carbon. The extraction of iron is only 68 per cent. of that present in the ore, most of the loss being due to prill of iron entangled in the viscous slag. The process is particularly interesting, as detailed records of the production of cast-iron in furnaces of such a primitive type are not numerous. The industry is very evidently Chinese in its origin, and it seems obvious that it owes little or nothing to European influences.

DURING the forced rest from his usual busy, scientific work Dr. H. R. Mill recently spent three and a half months in New Zealand, and visited the meteorological stations between Stewart Island, in the south, and the Bay of Islands, in the north, in which he was assisted in every way by Mr. D. C. Bates (Dominion Meteorologist) and others. He has embodied his impressions and notes obtained of the climate in an interesting article, untrammelled by tables or diagrams, in *Symons's Meteorological Magazine* for December. Among many other matters, he points out that although Great Britain lies nearer the pole than any part of New Zealand, the climates are much alike, summer in the South Island being apparently no warmer than in England; the lower latitude, however, ensures a greater intensity of sunlight, and vegetation proves that the mean temperature of winter is much higher than Great Britain. The prevailing wind being westerly, the mountains receive a rainfall exceeding 100 in. in many places, while on the east much of the area has an average of less than 20 in. The climate of the North Island is decidedly warm in summer, and there is a marked contrast between the two seasons. Great faith is attached to the weather forecasts; weather conditions being simpler the prognostics are less liable to misinterpretation than in Western Europe. Changes and movements of clouds appear to be more expressive of weather changes than in this country, and much use is made of them in filling up the gaps in telegraphic reports.

IN the *Comptes rendus* of the Paris Academy of Sciences for November 30 M. Colardeau describes an X-ray method of localising foreign bodies imbedded in the tissues. The matter is of special importance at the present time on account of the war, and during the past few months many suggestions have been made. The Röntgen Society, under the presidency of Sir Alfred Pearce Gould, has already devoted its December meeting to the question, and a further discussion is arranged for January. M. Colardeau's method differs but slightly from the plan introduced some years ago, and now almost universally adopted with the addition of minor improvements, by Sir James Mackenzie Davidson.

THE Journal of the Washington Academy of Sciences for December 1 contains an abstract of a paper by Mr. L. W. Austin, of the Naval Radio-telegraphic Laboratory, on quantitative experiments in radio-telegraphic transmission. The signals were sent from the station at Arlington, Virginia, which uses the Fessenden rotary gap giving an antenna current of 100 amperes and a wave-length of 3800 metres. The aerial is triangular with a mean height of 400 ft. Short-range experiments showed that owing to insufficient conductivity of the soil the effective height of the antenna was only 200 ft. The strength of the signals was determined by the shunted telephone method on board the U.S.S. *Birmingham* on a voyage to Gibraltar and back. The effective height of the receiving antenna was 114 ft., and the effective resistance 50 ohms. For distances between 300 and 2000 miles the strength, I_R, of the received signals could be expressed by the equation $I_R = (120\pi h_S h_R I_S / \lambda d R)$ exp. $(-0{\cdot}0015 d/\sqrt{\lambda})$, where h_S and h_R are the effective heights of sending and receiving antennæ, I_S the sending antenna current, λ the wave-length, d the distance of the stations apart, and R the resistance of the receiving system. This is a slight modification of the theoretical expression given by Sommerfeld. The complete paper will be published in the Bulletin of the Bureau of Standards.

MESSRS. BURROUGHS WELLCOME AND CO., Snow Hill Buildings, have sent us a copy of the Wellcome Photographic Exposure Record and Diary for 1915, which is a neat little pocket-book with a strong canvas cover. Having been issued for several years, and each year revised and brought up to date, it is now the most compact essence of photographic information—a veritable "tabloid." If you want to know how to tone bromides green, how much flashlight powder to use, about night photography, about speeds of papers and plates, and about a host of other requirements of the photographer, whether amateur or professional, you have only to look into this pocket-book where the information is dealt with clearly, tersely, and accurately. Practical experience of practical men is embodied in these pages, and the experience culled by experiments and long practice is analysed and set forth in simple formulæ and precise directions, not only helping the beginner, but saving him time, trouble, and material. The Wellcome Exposure Calculator, fitted ingeniously in the inside of the back cover, has only to be used once to be used always. By one turn of the scale the correct exposure for any plate or film is immediately given for any time of day or year. Blank forms are given for the entry of all details about each photograph taken, and these are followed by a diary for entry of ordinary daily memoranda. The book is issued in wallet form, complete with pencil, and three editions are published, suitable for the northern hemisphere, the southern hemisphere, and the United States. It is a cheap shillingsworth, and every photographer should invest in one.

FIVE short papers on audible and other cab signals on British railways were read and discussed at the Institution of Mechanical Engineers on December 18. These papers express the opinions of engineers connected with, and describe experiments which have been in progress on, the Midland, Caledonian, North-Eastern, Great Western, and Metropolitan Railways. It is generally admitted that the present system of semaphores and lamps is not entirely trustworthy, and it is hoped that some standard system of cab signalling which will be effective may be evolved soon. As was pointed out by Mr. Blackall, of the Great Western Railway, it is very important that some standard should be conformed to, so that the engines belonging to one railway passing over to the system of another may be able to pick up the signals which would ordinarily be given to the engines belonging to the latter system.

A NEW Diesel marine engine, built by Messrs. Doxford and Sons, of Sunderland, is described in the *Engineer* for December 25. In this engine the complicated cylinder cover casting with its valve arrangements is got rid of by having two pistons in the cylinder working in opposite directions. The upper piston is attached by a piston rod to a compensating arm, which is connected by two rods, one on each side of the cylinder, to two cranks placed at 180° to a central crank; the lower piston is connected in the usual manner to the central crank. The various operations in the cycle take place between the two pistons. The exhaust escapes through ports in the top end of the cylinder; these are uncovered by the upper piston when near the top of its travel. Scavenging air is admitted through corresponding ports at the bottom end of the cylinder; these are uncovered by the lower piston, and ensure a capital flow of scavenging air throughout the whole cylinder. The admission valves are placed at the middle zone of the cylinder. Cooling water is supplied to the lower piston through a rocker arm, and to the upper piston through a telescopic tube; the latter arrangement is open to some criticism on account of the difficulty of preventing leakage.

THE issue of "Hazell's Annual for 1915" is now ready. This is the thirtieth year in which this useful "record of the movements of the time" has been published. Some idea of the number of topics dealt with may be formed from the fact that the index to the volume contains close upon 20,000 entries. As is natural, great prominence is given to facts in connection with the war, but this engrossing subject is not allowed to overwhelm the other matters of importance dealt with in previous issues. A section entitled "The March of Science," runs to about thirty-four pages, and includes a summary of the proceedings at the British Association meeting in Australia, and a *résumé* of progress in scientific research during 1914. We are glad of the opportunity to extend the praise offered in these columns to the trustworthiness and completeness of previous editions of the annual to the present issue, the price of which is 3*s*. 6*d*.

MR. C. BAKER, 244 High Holborn, London, has issued his January list of second-hand scientific instruments which he has on sale or for hire. Particulars are given of more than 1500 pieces of apparatus, prominent among which are numerous microscopes and telescopes and their accessories. Every instrument is guaranteed to be in adjustment, and arrangements can be made for workers in the country to have pieces of apparatus on approval.

OUR ASTRONOMICAL COLUMN.

A REMARKABLE METEOR.—On Tuesday, December 15, at 6h. 25m. p.m., an extremely slow-moving meteor was seen by Mr. W. F. Denning at Bristol, and by Mrs. Wilson at Bexley Heath. It had rather a long flight, and was much brighter than a first magnitude star. The meteor was curious as belonging to a radiant point in Aquarius at about 336°–12°, and at the same position as the July Aquarids. No meteors have hitherto been recorded, so far as is known, from this radiant so late in the year. The object of December 15 last had a height of from sixty-seven to forty miles, its luminous course extended more than seventy miles, and its velocity was fourteen miles per second. The meteor must have been observed by many persons, the night being very clear and the object a very conspicuous one with an extensive trajectory. At the middle of December a well-defined shower of slow meteors from between α and β Persei at 48°+44° was prominently active. This same radiant has been observed at many other times of the year, but never before on December 15 and 16.

PARABOLIC ORBITS OF METEOR SWARMS.—In the Publications of the Leander McCormick Observatory (vol. ii., part 4) a paper on 126 parabolic orbits of meteor swarms is published by Mr. Charles P. Olivier, these deductions being made by him from more than 2800 observations of meteors, the combined work of the American Meteor Society. Mr. Olivier directs particular attention to the excellent work carried on by this society in spite of its youth, and hopes for more ideal methods of work in the future. It may be remembered that the author previously (1911) published a paper entitled "175 Parabolic Orbits and other Results Deduced from over 6200 Meteors," which appeared in the Transactions of the American Philosophical Society, N.S. (vol. xxii., part 1), and the present contribution may be considered practically a continuation of the above, the first radiant here numbered, namely, 177, following serially the radiants given in the 1911 publication.

One of the chief problems of meteoric astronomy is that of stationary radiants, and in many quarters it is considered that many of them exist, while other workers on theoretical grounds look upon them as mathematically impossible except in a few cases. Mr. Olivier attacks the problem by inquiring into the method of the reduction of the radiant points, and concludes that the usual process of combining observations of many successive dates, and radiants which lie sometimes as much as 10° from one another, etc., tend to influence greatly the result. His results, reduced separately for each date, "show almost no evidence of stationary radiation, and so far as they go may be considered to disprove its existence." Numerous interesting tables accompany this paper, among which may be mentioned that containing the 126 parabolic orbits; elements based on eight radiants suggesting these meteors were originally intimately connected with Halley's comet; ten orbits belonging to the main Perseid stream, confirming their connection with comet 1862 III., or Tuttle's comet, and other tables giving the magnitudes of the meteors seen, percentages of meteors of a given magnitude to the totals seen, and their colour and duration.

THE SPECTRUM OF 10 LACERTÆ.—The star 10 Lacertæ (R.A. 22h. 35m., declination +38° 32′, magnitude 5·0) displays a spectrum which is conspicuous for the sharpness of the important line at wave-length 4686 and of the other lines of hydrogen and helium. This star is therefore not only suitable for a good determination of its radial velocity, but affords an opportunity of obtaining an accurate measure of the stellar wave-length of the line at 4686 and other lines. Both these objects have been investigated by Messrs. E. B. Frost and Francis Lowater, and the results are described in the *Astrophysical Journal* for October (vol. xl., No. 3, 1914, p. 268). The line 4686 is now generally regarded as a line in the principal series of helium, and the laboratory work of Prof. Fowler has consigned to it the wave-length 4685·90. The line is recorded in the spectrum of the chromosphere with the following wave-lengths:—Lockyer λ 4685·90, Dyson λ 4685·86, and Mitchell λ 4686·00. The wave-lengths which the authors have now deduced from fifteen plates of the star are as follows:—

Frost: 4685·897 ± 0·016 (15 plates).
Lowater: 4685·903 ± 0·018 (15 plates).
Mean: 4685·90.

Other important lines, the stellar wave-lengths of which are here deduced, are λλ 4116·33, 4097·55, and 4089·12, closely approximating to the wave-lengths given by Lockyer in ε Orionis, namely, 4116·54, 4097·59, and 4089·14. With regard to the radial motion of the star, the motion of the system is given as probably −12 km., almost wholly due to the solar motion. From one plate they give the velocities of the two components, but state that the data are insufficient for indicating the period of the star, but "there seems to be little to suggest a period of less than several days."

THE ORBITS OF δ ORIONIS, R.Z. CASSIOPEIÆ AND R.X. HERCULIS.—Nos. 15 and 16 of vol. iii. of the Publications of the Allegheny Observatory describe the researches by Mr. Frank C. Jordan on the orbits of δ Orionis and R.Z. Cassiopeiæ. In the case of the former, thirty-six spectrograms of the star were secured with the Mellon spectrograph during the period 1908 to 1912, and these were used for the determination of the orbit and at the same time to rediscuss Hartmann's results. A comparison of the elements derived shows that the shape and size of the two orbits are practically identical. The radial velocity of the system has different values in the two derived orbits, but this difference is stated to be apparent rather than real. If, however, it should be proved to exist, the author states that "it would imply a third body, making the system similar to that of Algol." R.Z. Cassiopeiæ exhibits a light variation of an Algol-type star, and Mr. Jordan summarises the various values of the period derived by previous workers. The earliest spectrographic observations of the star were made in 1906 by Hartmann, and while he found a velocity range from +33 to −112 kilometres, this agrees well with the range of the definitive curve here given, namely +28 to −111 kilometres. For the present discussion seventy-one plates were employed, taken during the years 1910 to 1913, and tables are given showing the velocities deduced from each plate, the wave-lengths and origins of the line employed, etc.

Mr. Harold Shapley, in the *Astrophysical Journal* for November (vol. xl., No. 4, p. 399) contributes a paper entitled "The Spectroscopic Orbit of R.X. Herculis Determined from Three Plates with a New Photometric Orbit and Absolute Dimensions." He shows that the solution for the elements of the spectroscopic orbit of a faint star is possible when only a few measures of the radial velocity have been determined, provided that the system is an eclipsing binary and that the period, epoch of minimum, eccentricity, and longitude of periastron have been derived from the light curve. In his summary he states that the new photometric orbit of R.X. Herculis has been computed from unpublished observations obtained at Harvard and Princeton. The alternate minima are found to differ in depth by nearly a tenth of a magnitude. The stars are nearly equal in size, and are sensibly spherical. Their surfaces are separated by three times the radius of the larger star. From measures of lines on three plates it has been possible to derive very satisfactory spectroscopic orbits of both components. The combination of elements from the photometric and spectroscopic orbits gives the actual dimensions of the stars. The parallax of the system is found to be 0·006″.

AGRICULTURE AND THE WAR.

AT the half-yearly meeting of the Agricultural Education Association, just held in London, a discussion was held upon "Agricultural Products Deflected by the War." The chairman of the association, Prof. Somerville (Oxford University), presided, and there was present a large gathering of members, including Sir Patrick Wright (Board of Agriculture for Scotland), Mr. J. F. Blackshaw (Board of Agriculture), Prof. Barker (Bristol University), Profs. Seton and Crowther (Leeds University), Prof. Gilchrist (Armstrong College, Newcastle-on-Tyne), Dr. Goodwin (Midland Agricultural College), Drs. Russell and Hutchinson (Rothamsted), Prof. Hendrick (Aberdeen University), Prof. Bryner Jones (Aberstwyth), the hon. secretary, Mr. P. Hedworth Foulkes (Harper Adams Agricultural College), and others.

We give a summary of the remarks made by Dr. Russell, director of the Rothamsted Experimental Station, in opening the discussion:—

The object of to-day's discussion is to see how agriculturists are likely to be affected by the dislocation caused by the war, and what line we, as expert advisers to the farmer, ought to take. There can be no doubt about the main duty of the farmer in the present crisis. He must by all means in his power increase the saleable output from his farm, particularly of those things which the community needs most—a need which is expressed by an increase in price. In framing this advice it must be remembered that the ordinary unit of time for the farmer is the length of the rotation, but in these special circumstances the unit might well be altered to the duration of the war. Thus a scheme which would usually be condemned as bad husbandry from the ordinary rotation point of view might nevertheless be advantageous in the new conditions.

Roughly speaking we may classify the agricultural products affected by the war into two groups: those which are permanently affected, and those which are only temporarily affected. Correspondingly there must be two methods of ascertaining their value to the farmer: careful investigations for permanent purposes, and more rapid and necessarily less accurate trials for temporary purposes.

Palm nuts are fortunate in coming within the purview of the West African Committee, under the guidance of Sir Owen Phillips, and thanks to their enterprise all of us here have been duly informed of the character of this product, while a number of experiments have been put in hand to test its possibilities for British agriculture. For permanent purposes a full investigation is required, and will, of course, be given. Continental experience has shown that the material is good; at the same time we know that it has been put on the market before, and it did not take permanent hold. Apparently no serious fault was found with it, yet it never became part of our regular concentrated food for stock. There must be a reason for this, and the object of the investigation will be to ascertain what it is.

Other products of like nature are no doubt available or will become so—and will probably form the subjects for investigation. But there is an emergency problem that is quite different in nature and wants altogether different treatment. We have seen during the last five months a marked rise in the price of cereals. This is an expression of the fact that the community wants these particular goods, and the farmer must do his best to supply them. Now many farmers do not grow their winter oats entirely for sale. Part—often the greater part—of the stock is kept back for their own horses. Much food also is produced for stock. The important emergency problem arises: Can we recommend any ration in which imported or other products, cheap in price because they are not now needed by the community, can replace and liberate from the farm home-grown produce that is wanted elsewhere? Time will not allow of a full investigation, and the advice must often be based on foreign work or on past experience elsewhere. Short, rapid trials alone will meet the case. It is not necessary that the whole stock should be liberated; an increased sale of only 10 per cent. from every farm would add very materially to the quantity available for the community.

The replacement, of course, must be done without prejudicing the total food supply; thus we must not advise the production of grain at the expense of milk or of meat; our main concern will be to increase the saleable output.

Another type of product is only temporarily affected. A certain amount of guano which used to go to Belgium is now available. Shoddy or wool waste may be confidently expected in quantity whilst the Yorkshire mills are kept going so busily. There are also considerable amounts of sulphate of ammonia obtainable.

In time of peace cereals are often grown simply on residues of previous crops. Probably in every district the agricultural adviser knows of some manurial scheme that would make use of these products and increase the yield. It cannot be too strongly urged that demonstrations should be put in hand as speedily as possible to show how this can be done. The cost of the manurial scheme should not be too high; these are not times when speculative propositions can be undertaken, but only those that are likely to prove successful. It is certain that the area under wheat has been increased this year; the efforts of the agricultural adviser should be extended now to an increase in the yield per acre. Potash must remain a difficulty until the present search for new supplies is rewarded with success.

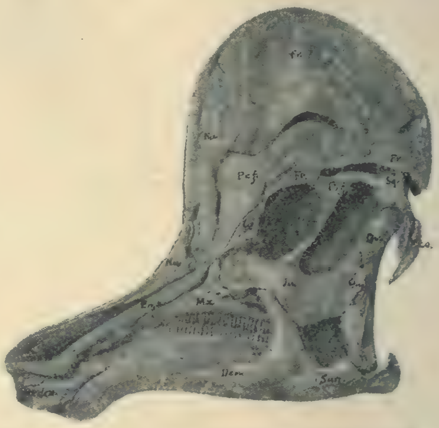
A third problem of importance is this:—Are any rearrangements possible whereby products not likely to be in much demand shall cease to be produced? This applies more particularly to horticulturists and market gardeners than to agriculturists. Early cucumbers, for example, have hitherto gone almost entirely to Germany, and this fact was realised in time to prevent growers from trying to raise them. The production of certain fruit and other market garden produce may require similar readjustment.

In conclusion, the time is appropriate to urge on all our farmers the need for reducing all waste to a minimum. The ordinary farm compares badly with modern manufacturing concerns in this respect; considerable amounts of material are left to waste on the plea that it is not worth while doing anything better. It can never be too strongly urged that waste is a sign of bad farming, and the present is a good time for reform.

NEW CANADIAN DINOSAURS.

TWO very remarkable new types of Canadian Cretaceous dinosaurs are described by Mr. Barnum Brown in the first and last of a consecutive series of three papers published in vol. xxxiii., pp. 539–65, of the Bull. Amer. Mus. Nat. Hist. The first of the triad is devoted to Anchiceratops, a member of the horned group (Ceratopsia) from the Edmonton beds of Alberta, characterised by the great size of the knobs bordering the nuchal flange, and the pair of large oval vacuities by which the latter is pierced. Special interest attaches to this type from the fact that it serves to explain the mode of origin of the ceratopsian flange. In the smaller and less specialised type represented by Monoclonius the supra-occipitals form a pair of hook-like opposing processes on the hind border of the upper surface of the skull, leaving a mushroom-shaped interval between them, and a pair of very large vacuities in the skull-roof. In Anchiceratops the supra-occipital processes have united in the middle line, where only a remnant of a central fontanelle is left, while the vacuities in the lateral portion of the cranial roof are very much smaller. Finally, in Triceratops, which is both the largest and latest member of the whole group, all vacuities have disappeared from the cranial roof and the nuchal flange attains its maximum development.

In the second paper the author describes and illustrates a nearly complete skull of the aforesaid Monoclonius from the Belly River beds of Alberta, which exhibits very clearly the features just referred to. But by far the most interesting of all is the skull (associated with the skeleton) of a trachodont dinosaur from the formation last mentioned, remarkable for the elevation of the cranial region into a tall, helmet-like crest, formed by the nasals, prefontals, and frontals. This unique conformation recalls the skull of the helmeted cassoway—a feature commemorated in the specific portion of the name (*Corythosaurus casuarinus*) proposed for this new type. As minor features of the skull (the figure of which is herewith reproduced on a reduced scale) may be mentioned its relative shortness, the narrow beak, and the small size of the narial aperture.



Skull of *Corythosaurus casuarinus*. About one-tenth natural size. *Den*, dentary; *Ex.O*, exoccipital; *Fr*, frontal; *Ju*, jugal; *La*, lachrymal; *Mx*, maxilla; *Na*, nasal; *Pmx*, premaxilla. *Po.f*, postfrontal; *Pr.den*, predentary; *Pr.f* prefrontal, *Qu*, quadrate; *Sur*, surangular; *Sq*, squamosal.

At the close of this paper Mr. Brown proposes a revised classification of the Trachodontidæ, which he divides into the two families Trachodontinæ and Saurolophinæ, the latter characterised by the presence of a cranial crest which is lacking in the former. The first group is represented by the genera Trachodon, Kritosaurus, Hadrosaurus, and Claosaurus, and the second by Saurolophus, Hypacrosaurus, and Corythosaurus.

R. L.

GEOLOGY IN AUSTRIA-HUNGARY.

THE widely representative character of the work of the Geologische Reichsanstalt of Vienna is fully maintained in recent issues of the *Jahrbuch*. One of the most notable publications from the point of view of students and teachers of geology is that by O. Ampferer and W. Hammer, entitled "Geologischer

Querschnitt durch die Ostalpen vom Allgäu zum Gardasee" (lxi. Bd., 3 u. 4 Heft, p. 513). This includes a critical description, district by district, of a coloured section drawn on the horizontal and vertical scale of 1 : 75,000, and published with this double part of the *Jahrbuch* as a folded illustration three and a half metres in length. The authors acknowledge their indebtedness to the administration by the Reichsanstalt of the Urban Schlönbach travelling-fund. Bibliographies are appended to each division of the description, and the whole may be regarded as a development and replacement of the remarkable single-handed work of Rothpletz, published in 1894. The authors point out (p. 535) that Rothpletz recognised the influence of great overthrusts, being in this matter a pioneer well ahead of most of his contemporaries.

The geological section includes subsidiary profiles in the overfolded limestone Alps of the Lechtal area, which have since provoked some criticism in the *Verhandlungen* of the institute; a traverse of the upper Inntal under the Piz Lischanna; the Trias of the Ortler, with schists overlying it on the north; the injection-gneisses of Monte Tonale; the huge masses of tonalite in the Adamello mountains; and, finally, the contorted Triassic series of the Val Sabbia, leading down to the Lake of Garda. Numerous detailed sections are added in the 180 pages of text. The systematic exposition that characterises Ampferer's work is recognisable in the account of the structure of the northern limestone Alps (pp. 669–83), accompanied by diagrams that would have delighted the heart of G. P. Scrope, and in the general summary (pp. 697–709), in which stress is laid on the absorption of masses of rock into the depths as a source of mountain-folding. It is urged that the structures now visible are based on much that is invisible, and that the folded matter is not merely superficial, but represents the crests of masses which have sunk deeply into the crust. The complete alteration, largely by thermal processes, of these sunken masses, renders the discovery of root-regions for the folded upper layers impossible. These upper layers assume anomalous positions in regard to one another through fracture and overthrusting, and not through the formation of flattened and continuous overfolds. While a localised region of the deeper crust is softened and gives way, the more rigid masses on either side close in and crumple the weakened portion, pressing a large part downward, but leaving the superficial layers above it contorted and even upthrust above the general surface. "Der grosze Massenüberschusz an der Oberfläche ensteht durch Einsaugung tieferer Zonen erdeinwarts." The authors argue that the visible crystalline masses beneath the strata that are overthrust, or, on the Decken theory, overfolded, form far too narrow saddles, and could not have underlain the broad region that would be occupied by the upper rocks if these were spread out in their original positions. Hence something has disappeared from the lower zones by absorption into the unseen regions of the crust.

O. Ampferer is also concerned (lxii. Bd., p. 183) with a scheme for the representation of far more detail than is usual on geological maps. He indicates the actual strike of outcropping strata by continuous coloured lines on the contoured topographical sheet, so that we can see at once how the edges of the rocks lie on mountain-slopes or across valley-floors. He also proposes to show, by a scheme of dots of various shapes and colours, the character of detritus on the surface and its origin from the several rocks that enter into the structure of the district.

R. v. Klebelsberg (lxii. Bd., p. 461) reviews the marine fauna of the Ostrau Beds of Moravia and Silesia, and concludes that the marine intercalations represent transgressions, in Middle Carboniferous and Lower Coal-Measure times, from the sea that lay continuously over Russia in the Carboniferous period. He hopes for a correlation of these overflows with those of Britain, Belgium, and Westphalia, since they may record events of wide significance, though of short duration. The positions of these marine bands in the Ostrau Beds is shown in sections by W. Petrascheck (lxiii. Bd., plate 14). The marked folding of the Upper Silesian coalfield occurred in Permian times.

E. Hartmann, of Munich, inspired by Rothpletz, furnishes a detailed study of "Der Schuppenbau der Tarntaler Berge am Westende der Hohen Tauern" (lxiii. Bd., pp. 207–388). Numerous types of rock are described that are due to deformation and mylonitisation during overthrusting, and the glaucophane-schists (p. 332) are referred to a mixture of diallage-hornblende rock with the slates into which it has intruded. The three flake-like sheets that have been piled on one another by the Alpine overthrusting are held to have been folded later (p. 376) by earth-movements from north-west to south-east, and, to a less degree, from east to west. The author, like many workers in the eastern Alps, finds that the phenomena are explicable by overthrusting, rather than by a transference of material from a distance as part of a great overfolded sheet.

Franz Kossmat (lxiii. Bd., p. 171) deals with the folded structure of the interesting region of potash salts in the Miocene system of East Galicia. Franz Toula (*ibid.*, p. 621) continues his work in western Bosnia, and describes a number of Triassic cephalopods, which appear to differ little from species established by Mojsisovics. G. Schlesinger (lxii. Bd., p. 87) discusses the ancestry of the proboscideans in the light of an unexpected discovery of *Elephas planifrons* in Lower Austria. The remains come from strata that are at the latest Middle Pliocene, though younger than the Pontian, with its Pikermi type of fauna (p. 93), and the occurrence in Europe of this typical Siwalik species leads the author to trace the known species of elephants from their source in the Fayûm to Europe and North America. He regards *E. planifrons* as passing from India through Europe to Africa, and as the direct ancestor of *E. meridionalis* (p. 150). The dwarf elephants of the Mediterranean islands are referred to a double origin, both the ancestors, *E. planifrons* and *E. antiquus*, being, however, normally large forms (p. 171), and Schlesinger adopts Abel's view that their degeneration in teeth and size arose from the close interbreeding necessitated by geographical changes.

Franz Kretschmer's studies on the "Kalksilikatfelse" in the gneiss of Moravia (lxii. Bd., p. 359) form an important addition to the literature of eclogites and amphibolites. It is now well recognised that these rocks, which are so common as inclusions in fluidal gneiss, are, in a great number of cases, residues of calcareous strata invaded by a granite magma.

The series of papers published in the *Verhandlungen* of the Reichsanstalt often contain new stratigraphical conclusions, new records of fossils, and at times illuminating criticisms. The controversy as to the structure of the imposing limestone mass of the Wetterstein, which forms the northern wall of Tyrol above Partenkirchen, is sustained by O. Ampferer (1912, p. 197) and O. Schlagintweit (1912, p. 313). The former demolishes, with accompanying diagrams, certain impossible readings of the local structure; the latter opposes Ampferer's view that the mass has been thrust from east to west, and continues to connect it with the overthrust sheet of the Inntal, and not with the underlying Lechtal sheet. The Cainozoic beds north of the Carpathians are studied by W. Petrascheck (1912, p. 75), who indicates (p. 92) an interesting groove, parallel with the range, in which they assume an unexpected thickness above the Coal-Measures. The problem of their faulting-down, infolding, or original deposition in a hollow of erosion, reminds us on a smaller scale of that of the Indo-Gangetic plain (see Nature, vol. xciv., 1914, p. 347). W. von Friedberg, of Lemberg (1912, p. 367) compares the fossil contents of the Polish Miocene with those of Miocene beds in Austria, North Italy, and France, and concludes that the Burdigalian is absent, that the salt-series is Helvetian, and that the Tortonian extends below and also above the gypsum-bearing strata of Podolia. The beds with the brackish-water mollusc Oncophora are held to be somewhat younger than those of Bavaria, and to represent (p. 387) the first arrival of the Miocene sea in Podolia in Upper Helvetian times. References to these beds in Moravia will be found in a note by A. Rzehak (1912, p. 344).

An interesting feature in mountain-structure is shown in sections by G. Geyer (1913, p. 293) of the Toten Gebirge on the border of Styria and Upper Austria, where gypsum-bearing beds have been squeezed up like dykes into limestones of much later date. As an example of critical reviewing, we may cite the extremely valuable summary by F. Katzer (1911, p. 387) of Cvijić's researches in Macedonia and the Balkan peninsula as far as the Dardanelles, which have been mostly published in the Servian language. The origin of the Bosporus-Dardanelles river-cut comes in question (p. 417). We have kept until the last a mention of a discussion by O. Ampferer of Penck's well-known association of terminal moraines and outwash-plains (1912, p. 237). While we think that Ampferer distinctly underestimates the amount of water that may escape from an ice-front of continental magnitude through a loosely piled block-moraine, his citation of the filtering effect of a terminal moraine is distinctly useful. He thus cannot admit the association of a large terminal moraine with an extensive "apron." The two structures, for him, should be in inverse proportion. Ampferer does good service (p. 238) in pointing out an anomaly in Penck's diagram of a double moraine-wall enclosing a "Zungenbecken." This figure has been extensively reproduced, but has puzzled other geologists. How was the outer moraine piled up if the inner one was not destroyed? On the other hand, if it is the older of the two, why do its outwash-products overlie those of the inner wall?

G. A. J. C.

ON SALTS COLOURED BY KATHODE RAYS.[1]

PERHAPS a part of the phenomena which I am about to discuss is already familiar to you all. I shall not bring forward many hypotheses. So you will perhaps ask why I should speak at all. And, in fact, apart from reference to certain facts not published hitherto, my intention is mainly to invite the interest of men younger and abler than myself in a class of phenomena which seem to constitute a new condition of matter, but on which very few have yet worked.

If kathode rays fall on certain salts—for example, common salt, or chloride of potassium, or potassium bromide—vivid colours are produced immediately on these salts.[2] Thus common salt becomes yellow-brown (like amber), potassium chloride turns into a beautiful violet, potassium bromide becomes a deep blue colour quite like copper sulphate. Here you see a specimen of common salt transformed in this way on the surface of the single crystals into a yellow-brown substance. I show also sodium fluoride, which takes a fine rosy colour.

The colours so acquired in a very small fraction of a second may be preserved for a long time, even for many years, if the coloured substances are kept in the dark and at low temperatures. But in the daylight, and also under heat, the colours will gradually disappear until the original white condition is reached again.

The colours of different salts are sensitive to heating in a very different degree. I could show you the yellow sodium chloride, prepared some months ago in Europe, but I cannot show you here the violet KCl and the blue KBr, because these colours, even in the dark, do not stand the heat of the equator. The same salt, if dissolved, may keep very different colours, according to the medium in which it has been dissolved, even when the pure medium itself cannot be coloured at all by kathode rays. I am speaking of *solid solutions*, produced by fusing a small quantity—for instance, of common salt or of certain other alkali salts—together with a great mass of a salt which remains itself colourless in the kathode rays, as, for example, the pure potassium sulphate. Lithium chloride acquires a bright yellow colour in the kathode rays; but if dissolved in potassium sulphate a lilac hue is produced, as you may see in this specimen. Likewise the pure carbonate of potassium acquires a reddish tint, but after dissolving it in the potassium sulphate it becomes a vivid *green* in the kathode rays, as you see here.

Very small admixtures are sufficient to produce intense colours. So 1/25,000 of carbonate will produce the green colour in the potassium sulphate; even 1/100,000 gives a marked colour, and an amount of certain admixtures, which I estimated as 1/1,000,000 only, may produce a slight but quite perceptible coloration in some salts. So if you work with potassium sulphate which you obtain from chemical factories guaranteed as chemically pure, you may observe a set of different colours in these preparations under the kathode rays, by which you will detect the nature of the different small admixtures which adhere to the pretended pure preparations of the different factories. In this way a new analytical proof, much more sensitive than the ordinary chemical methods, is obtained, and impurities may be detected even when a certain specimen of salt contains more than a single impurity, because the colours produced by different admixtures generally disappear with different speed in the daylight or under rise of temperature. For instance, the ordinary potassium sulphate turns to a dark grey with a slight greenish tint at first. After a short while the very sensitive grey will disappear, simply under the ordinary temperature of the laboratory room, and a vivid green comes out. The grey hue indicates a very small amount of sodium chloride, 1/100,000 or so, and the remaining green indicates the admixture of a carbonate. Here are some preparations of potassium sulphate each containing a single small admixture (K_2CO_3, Li_2CO_3, LiCl, KCl, KBr). You will notice how different are the colours of the originally white substance, varying from green to bluish-grey, ash-grey, greyish-blue, and violet.

By fractional crystallisation one may finally get a really pure preparation of potassium sulphate, which is no longer coloured by kathode rays (or only in a very slight degree, indicating minimal traces of sodium chloride). But there are other preparations which, so far as I know, cannot be acquired in pure condition by any means, not even by fractional crystallisation. I never came across a pure sodium sulphate—the purity exists only on the manufacturers' labels. Even the best preparations of this salt contain an amount of sodium carbonate which up to the present cannot be separated from it, not even by frequent fractional crystallisation. The colour produced by the small admixture, which always remains, is a very marked ash-grey. By an intentional further addition of sodium carbonate the colour becomes nearly black.

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[1] By Prof. E. Goldstein. A paper read before Section A of the British Association at the Australian meeting, and ordered by the General Committee of the Association to be printed *in extenso*.

[2] E. Goldstein, *Wiedem. Ann.*, liv., 371; lx., 491; *Phys. Zeitschr.*, iii., 149; *Sitzungsber. Ber. Akad. d. Wiss.*, 1901, 222.

The question arises: What may be the cause of these colorations in pure salts and also in solid solutions of them? Shortly after the colours of the alkali salts had been discovered, an explanation was given,[3] according to which the phenomenon mainly consists in a chemical reduction. For instance, in the case of potassium chloride the chlorine would be set free, while the remaining potassium is dissolved in the unaltered main quantity of the salt, colouring it at the same time. And it seemed a convincing proof for this theory when Giesel[4] and also Kreutz, simply by heating rock salt in the vapours of sodium or of potassium, produced colours in this rock salt quite similar to those produced by kathode rays. It seemed that the problem was settled finally. However, it was soon discovered that the coloured Giesel salts, although they look to the eye quite like the kathode-ray salts, in all other respects behave quite differently. For instance:—

(1) The kathode-ray salts, as I mentioned before, are very sensitive to daylight: after an exposure to diffuse daylight of a few minutes—or in some salts even of several seconds only—the coloration diminishes, whilst the Giesel salts remain unaltered even when they are kept in full sunshine for days or even weeks.

(2) The kathode-ray salts, if dissolved in distilled water, show absolute neutral reaction; the Giesel salts are strongly alkaline.

(3) The kathode-ray salts give very marked photo-electric effects (as Elster and Geitel[5] observed); the Giesel salts are quite ineffective.

(4) In certain circumstances, which will be mentioned further on, the kathode-ray salts may emit a phosphorescent light, the Giesel salts none at all. Therefore the question arose again, Whether there is not a marked internal difference between the kathode-ray salts and the Giesel salts, and what is the nature of the latter?

I have succeeded in settling this question, having produced salts *by kathode rays*, the behaviour of which is in every respect *absolutely identical with that of the Giesel salts*. You may produce such substances if you allow the kathode rays to fall on the original salts not for a short moment only, but for a somewhat prolonged time, *until the salts are strongly heated*. Produced in this way the salts will keep colours; but the substances coloured in this way are *not* sensitive to light; they show no photo-electric effect; they give *strong alkaline* reaction, and they are not suited for phosphorescence—all like the Giesel salts. It is quite sure, and you may test it also directly by spectroscopic proof, that in this case, if for instance you have worked on sodium chloride, *the chlorine is set free*. Then, of course, an amount of free sodium is left, which dissolves itself in a deeper layer of unaltered sodium chloride, to which the kathode rays could not penetrate. I call these non-sensitive colours *the after-colours of the second* class, while the ordinary sensitive after-colours, produced in a short time on cool salts, are called after-colours of the first class.

Now, if the after-colours of the second class are identical with those of the Giesel salts, then, of course, the very different substances of the first class cannot be also identical with the Giesel salts. Therefore the question arises anew what is the nature of the first-class after-colours?

One observes with regard to solid solutions that the first-class colours depend not only upon the *metal* contained in the small admixture, but they vary greatly, for instance, in the case of the admixture consisting of potassium chloride or bromide or iodide. This indicates that the metals alone do not cause the after-colours. It becomes much more clear when we expose some ammonium salts to the kathode rays. (The ammonium salts are cooled by liquid air in the discharge-tube to prevent their evaporation.) Then you get strongly marked after-colours likewise; for instance, ammonium chloride becomes yellow-greenish, the bromide becomes yellow-brown, the iodide becomes brown, and the fluoride a deep blue. In the daylight these colours are gradually destroyed, quite like other after-colours of the first class. The colours themselves—yellow-greenish for the chloride, yellow-brown for the bromide, and so on—induce us to presume that the after-colours in this case are produced by the haloids, and not by the hypothetical ammonium radicle. This presumption becomes a strong conviction when we observe that also a great number of organic preparations which contain no metal at all (and not any metal-like radicle) acquire marked after-colours of the first class in the kathode rays also. (The part of the discharge-tube which contains the organic substances is cooled by liquid air.)

Then you may observe that solid acetic acid ($C_2H_4O_2$) remains quite colourless in the kathode rays; but if you substitute a hydrogen atom by chlorine, the substance thus produced (the monochloro-acetic acid) acquires a marked yellow-green after-colour. If you introduce an atom of bromine instead of chlorine, you get $C_2H_3BrO_2$, and the after-colour is of a marked yellow. Bromoform ($CHBr_3$) turns into the colour of loam, and chloral (C_2HCl_3O) becomes a deep yellow. In this way we see that not only salts, but likewise substituted acids, substituted hydrocarbons, and substituted aldehydes acquire after-colours if they contain any haloid.

Now, it seems highly improbable that in the case of alkali salts the electro-positive component is absorbed only (producing the after-colour), and that, on the other hand, in the ammonium salts and in the organic substances the electro-negative component is efficient only. The most probable inference is that in each case *both* components remain and that both are efficient, but that under the same conditions the haloids produce a slighter colour than the metals, so that in the case of the salts the haloid colour is overwhelmed by the metal colour.

Therefore we are compelled to suppose that we have not to deal with a decomposition in the ordinary form, by which the different components are finally separated from each other and at least one of them is set entirely free, but that the components detained by absorption remain at a quite short distance from each other, so that they may easily meet again. I realise that—for instance, in the case of sodium chloride—at every point of the coloured layer there is an atom (or perhaps a molecule) of chlorine and an atom (or a molecule) of sodium; but they cannot combine, because they are fixed by absorption and distended from each other by the absorptive power, which in this case surpasses the chemical affinity. But the absorptive power may be weakened by heating and the chemical affinity or the amplitude of the molecular vibrations may be strengthened by the energy of daylight.

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[3] E. Wiedemann and G. C. Schmidt, *Wied. Ann.*, liv., 618.

[4] F. Giesel, *Ber. D. Chem. Ges.*, xxx., 156.

[5] J. Elster and H. Geitel, *Wied. Ann.*, lix., 487.

If we grant these assumptions, it is immediately evident why the reaction of all dissolved colour substances of the first class is a neutral one, for the two components may combine again and re-establish the original substance. The other special qualities of the first-class colours, and especially their differences from the Giesel salts, which contain the electro-positive component only, may be deduced likewise from this retention of both components and their opportunity of meeting each other again when the absorptive power is weakened or the chemical affinity is strengthened. Now, the two components in the coloured substances being distended in some degree, I propose for this special condition of matter the name of *distension.* If we accept this, have we created a new name only, or does matter in this condition really show new qualities? It seems to me that we have to deal with a peculiar condition of matter, which deserves a more elaborate study than it has met until now. I will not enter again into some special qualities, which have already been mentioned—the photoelectric effect and so on—but I should like to point out that matter in the distension state shows a strongly strengthened absorption of light.

We noticed with regard to ammonium chloride the yellow-greenish after-colour of the chlorine. Now, kathode rays, as used in these experiments, will not penetrate any deeper than one-hundredth of a millimetre into the salt. In such a thin layer even pure liquefied chlorine would not show any perceptible colour. But besides this it must be noticed that we observe this after-colour at the temperature of liquid air, and that chlorine at this temperature, as Dewar and Moissan observed, is snow-white, even in thick layers. In a similar degree the brown colour of bromine is weakened at low temperatures. Now, if nevertheless we observe at this very low temperature the marked characteristic colours of chlorine and bromine, we must conclude that the absorptive power of these substances has become a multiple of its ordinary value. One may observe this strengthening of the absorptive power directly in the pure sulphur. Sulphur likewise turns into a snow-white substance if cooled by liquid air. But when the kathode rays fall on the white sulphur it takes immediately a yellow-reddish colour. It is a real after-colour, because at constant low temperature the colour is destroyed by daylight.

Now, since the strengthening of light absorption occurs in this elementary substance, it becomes evident that the cause cannot be any chemical process, but only a physical allotropy. The special character of this allotropy (which may be connected with an absorption of electrons) will not be entered on in a discussion here. Probably we have to deal with a polymerisation, so that, for instance, the yellow-reddish sulphur would be analogous to polymerised oxygen—to ozone.

I have mentioned already that the first-class after-colours are gradually destroyed by incident daylight. A peculiar phenomenon is connected with this destruction of colour. I found that after the daylight had fallen on the coloured substances, even for the shortest time, most of them showed a marked phosphorescence of long duration. I have observed this phosphorescence even in substances which had been coloured twelve years ago and had been kept in the dark since that time. The diffused dim light of a gloomy November day, when falling through a window on the coloured substance for one or two seconds only, is sufficient for the production of this phosphorescence in a marked degree. If you allow the daylight to fall several times on the same spot, then the colour is weakened at this spot, and we come to the presumption that the loss of coloration is generally attended by the emission of phosphorescent light. This is in accordance with the experience of Wiedemann and Schmidt that if the destruction of the colour is produced by heating, likewise a phosphorescent light is produced, which in this case is strong but of a short duration, corresponding to the quick destruction of the after-colours by strong heating.

If the salts, after having been coloured in the condition of a fine powder and then having been put between two glass plates (in order to obtain a plane surface), are placed in a photographic camera instead of the photographic plate, you may get a fine phosphorescent picture of a landscape or of architecture after a very short exposure.

Time does not allow me to mention in detail several other peculiarities which are shown by matter in the distension state. In one direction only I may be allowed to make some remarks.

The first-class after-colours may be produced not only by kathode rays but also by the β rays of radioactive substances, as you probably know. But they may also be produced by *ultra-violet light,* for instance, by ultra-violet spark light, even when a quartz plate is interposed between the spark and the salt. More than thirty years ago I brought forward a hypothesis, according to which in every point where kathode rays strike a solid body a thin layer of ultra-violet light-radiating molecules is produced in the gas, to which ultra-violet light of very short wave-lengths, for instance, the phosphorescence of the glass walls in the kathode rays, is due. But I came further to the assumption that nearly all effects which are commonly ascribed to special qualities of the kathode rays, and likewise of β rays and X-rays, are mere effects of the ultra-violet light which is produced by the stopping of these rays. I have been guided by this assumption during many years, and have very often been aided by it in foreseeing new phenomena. For instance, in this way I was induced to expect that the after-colours would be produced not only by kathode rays but also by the ordinary ultra-violet light; further I could guess that also the X-rays would produce after-colours (which in this case have been observed by Holzknecht), and in recent times I could foresee that solid aromatic substances (the benzene derivatives) in the ultra-violet light must change their spectra of ordinary phosphorescence, composed of broad bands, and turn to peculiar spectra composed of narrow stripes, the wave-lengths of which are characteristic of the single aromatic substances.[6] So I believe also that the after-colours are produced not directly by the kathode rays or by β rays, but by the aforesaid ultra-violet light which is connected with the stopping of the other rays.

In this way the after-colours enter at once into a great class of phenomena known as *reversible effects of light.* You know that certain effects of the visible spectral rays are destroyed by rays of longer wave-lengths, by the infra-red rays. And the analogy to this phenomenon is in my opinion the destruction of the after-colours: they are produced by the ultra-violet light of the stopped kathode rays and are annihilated by the longer visible wave-lengths of daylight. In this way you may likewise understand, for instance, that the coloured spots, produced by X-rays on the luminescent screens after long exposure, may be destroyed again by exposure of the screens to daylight. You may also explain the peculiar medical observation that therapeutic radium effects in parts of the human body not covered, specially in the face, are often not of long duration—for the face is exposed to the counteracting visible rays of daylight.

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[6] E. Goldstein, *Verhandl. d. D. Physik. Ges.*, xii.

We notice here a connection of our subject with a department of great practical importance. For all therapeutic effects of X-rays, radium rays, and mesothorium rays would, according to this view, be effects only of ultra-violet light produced by the stopping of these rays in the human body, and the special character of the radium- and mesothorium- and X-ray treatment would consist mainly in the carriage into the interior of the body, by the rays, of the ultra-violet light, which is not confined to the surface of the body, but is produced at every place where any of the entering rays are stopped. You may notice further that this view of the medical ray-effects presents a heuristic method for the treatment itself, which up to the present followed quite fortuitous and merely empirical paths. For it may be hoped that treatment by radio-active substances will be useful in every disease in which ultra-violet light has been proved to be efficient in some degree; you will avoid such treatment in the well-known cases in which light of short wave-lengths is noxious, and you may be justified in substituting an ultra-violet light treatment where radium or mesothorium is not obtainable. At the same time it becomes evident why the treatment of certain diseases by the β rays has effects very similar to those produced by *fulguration*—that is, by the light of very strong sparks; the efficient agent is in both cases the ultra-violet light.

But it cannot be a physicist's task to enter too far in medical questions: it was only my intention to show how interesting are some of the problems which are connected with the salts coloured by kathode rays.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

By the will of the late Dr. T. Bell, head of the firm of Messrs. Pyman, Bell, and Co., coal exporters and shipowners, of Newcastle, the sum of 3000*l.* is bequeathed to the Armstrong College, Newcastle.

THE report of the proceedings of the general committee for promoting the establishment of an Imperial College of Tropical Agriculture is referred to in the *Pioneer Mail* of December 4. It is stated that Mr. R. N. Lyne, Director of Agriculture, Ceylon, says he thinks that the West Indies will now support Ceylon's claims to be the home of the college. The committee resolved to take steps to raise 40,000*l.* for building and endowing the college, of which 20,000*l.* should be asked from the Governments concerned, including India, and the remainder be raised by public subscriptions, provided Government contribute the share stated. It was also resolved to collect 5000*l.* for the erection of a hotel for European students. The committee has not committed Ceylon for the site; at the same time it favoured that country.

SEVERAL bequests for higher education in the United States are announced in the issue of *Science* for December 18 last. Two gifts of 20,000*l.* each have been made for the development of a graduate course in preparation for business and business administration at the Sheffield Scientific School of Yale University. The two donors are graduates of the University. 2000*l.* has been given to Smith College by Mr. and Mrs. A. J. White, of Brooklyn. Half of the money is to be applied toward payment for recent improvements on the Lyman Plant House. A bequest of 2000*l.* to St. Lawrence University at Canton, N.Y., is made under the will of Mrs. Kate A. L. Chapin, of Meriden, Conn. Prof. and Mrs. Frederic S. Lee have given to Columbia University the sum of 4000*l.* to establish a fund for the use of the department of physiology.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Meteorological Society, December 16.—W. F. **Stacey**: The distribution of relative humidity in England and Wales. The author has prepared mean monthly and annual maps of relative humidity based on the 9 a.m. observations made at more than ninety stations during the ten years 1901–1910. An examination of these maps shows that in winter the air over the interior of the country is more moist than that over the coastal regions; that the minimum relative humidity occurs earlier in the year in the western parts of the country than in the eastern; that in summer the air over the interior of the country is drier than that over the coastal regions; and that the smallest range of humidity is found in the west and the greatest in the interior towards the east. The distribution of temperature is the chief determining factor in the distribution of relative humidity; while sea influence, the direction and character of prevailing winds, the configuration of the country all have important effects on temperature, and therefore on relative humidity.

Geological Society, December 16.—Dr. A. Smith Woodward, president, in the chair.—Prof. W. M. Flinders **Petrie**: The Palæolithic age and its climate in Egypt. The classes of worked flints peculiar in Egypt are:—(1) Irregular, with broad unregulated fractures. (2) Rounders, flaked in all directions to an edged disc. (3) Hoofs, very thick, rudely domed with an obtuse edge. (4) Lunes, with obtuse edges. (5) Crescent scrapers. Irregular flints, similar to those from St. Acheul, are found in high Nile gravels. The regular European types occur exactly like those classed as Chellean and Acheulian. The Mousterian forms are so often found in various periods, that they cannot be assigned without evidence of age. The Aurignacian survive into the early civilisation. The large class of flints from the Fayum desert comprises all the Solutrean types, and also Robenhausian forms. The flakes of the early civilisation (8000 to 6000 B.C.) are identical with Magdalenian. Views of the Nile cliffs show the general nature of the country and conditions. Successive changes of level are indicated by (1) the collapse of immense drainage-caverns far below present level; (2) the filling of valleys with débris up to 650 ft. above the present sea-level; (3) the gouging-out of fresh drainage-lines through the filling; and (4) rolled gravels on the top of cliffs 800 ft. above sea-level, since when there has been no perceptible denudation by rain. The great extent of these elevations and depressions is likely to be connected with similar movements at Gibraltar, which are believed to synchronise with the movements of glacial periods in northern Europe. The evidence of the flint ages agrees with this connection.

PARIS.

Academy of Sciences, December 14.—M. P Appell in the chair.—E. **Branly**: Intermittent conductivity of thin dielectric plates. A study of the conductivity of a thin plate of dielectric induced by the passage of a rapidly alternating current.—P. **Duhem**: The hydrodynamical paradox of M. Brillouin.—M. C. Jordan was elected vice-president for the year 1915.—M. **Bazy**: Statistical note on tetanus. A study of 129 cases of tetanus occurring in 10,896 wounded. In eight cases, the disease appeared fourteen or more days after the wound, one as late as twenty-seven days. Stress is laid on the valuable preventative action of the anti-tetanus serum. In hospitals where preventative injections have been made systematically the tetanus mortality is 0·42 per cent.; in hospitals where the injection is made in suspected cases only the mortality is 1·28 per cent. If only a limited amount of the serum is at the disposal of the surgeon, the amount injected may be safely reduced from 10 c.c. to 2 c.c.—F. **Gonnessiat**: Solar eclipses: formula for the correction of the elements.—Henri **Villat**: The paradox of d'Alembert and the theory of discontinuous movements.—H. **Bertin-Sans** and Ch. **Leenhardt**: The localisation of projectiles in the body by radiography.—O. **Lignier**: The staminal glands of the Fumaraceæ and their signification.—G. **Arnaud**: The suckers of Meliola and Asterina.—P. **Mazé**: Nutritive exchanges in plants. The rôle of the protoplasm.—Jules **Amar**: Relations between the feeding and strength of Arabs. Arabs were fed on two classes of diet of equal heat value, one following native custom the other French. The former proved more advantageous from the point of view of utilisation of the food in the form of muscular work.—J. **Blier**: Bovine hæmoglobinuria of Chili.—A. **Trillat** and M. **Fouassier**: The influence of the radio-activity of the air on the microbial water particles in suspension in the atmosphere.

NEW SOUTH WALES.

Linnean Society, October 28.—Mr. W. S. Dun, president, in the chair.—T. G. **Sloane**: Revision of Australian Carabidæ. Part v. Part v. deals with the Australian section of the tribe Helluonini, comprising seven extra-Australian, and twelve Australian genera, with twenty-seven species. Four genera and seven species are described as new.—E. **Petersen**: Australian Neuroptera. Part i. Two genera and five species are proposed as new, and supplementary information, with illustrations, of seven species previously described, is given—the entire series being referable to six families.—Dr. A. J. **Turner**: The Lepidoptera of Ebor Scrub, N.S.W. Ebor is a small township, fifty miles N.N.E. of Armidale, on the eastern edge of the New England Plateau, at an elevation of 4000 ft., with an abundant rainfall. Representatives of thirty-one species of Lepidoptera (fam. Arctiadæ, Geometridæ, Pyralidæ, Tortricidæ, Tineidæ) were collected in the scrub. Six genera and twenty-four species are described as new.—L. **Harrison**: Some Pauropoda from New South Wales. Four species of Pauropus, and one of Eurypauropus, are described as new, with observations on the development of one species of these delicate little Myriapods, now added to the Australian fauna.—T. G. **Sloane**: Description of a new tiger-beetle from North-Western Australia.

BOOKS RECEIVED.

Optic Projection: Principles, Installation, and Use of the Magic Lantern, Projection Microscope, Reflecting Lantern, Moving Picture Machine. By Prof. S. H. Gage and Dr. H. P. Gage. Pp. ix+731. (Ithaca, N.Y.: Comstock Publishing Company.) 3 dollars.

Exercises in Arithmetic and Mensuration. By P. Abbott. Pp. ix+524+Answers. Pp. 86. (London: Longmans and Co.) 4*s*. 6*d*.

Nature Notes for Ocean Voyagers. By Captains A. Carpenter and D. Wilson-Barker. Pp. xvi+181. (London: C. Griffin and Co., Ltd.) 5*s*. net.

Bacon's Sixpenny Contour Atlas. South-East England Edition. Pp. 41. (London: G. W. Bacon and Co., Ltd.)

Who's Who, 1915. Pp. 2376. (London: A. and C. Black, Ltd.) 15*s*. net.

Flies in Relation to Disease. Blood-sucking Flies. By Dr. E. Hindle. Pp. xv+398. (Cambridge University Press.) 12*s*. 6*d*. net.

The Journal of the Institute of Metals. Vol. xii. Edited by G. Shaw Scott. Pp. x+392. (London: Institute of Metals.) 21*s*. net.

DIARY OF SOCIETIES.

MONDAY, JANUARY 4.

ARISTOTELIAN SOCIETY, at 8.—Berkeley's Doctrine of Esse: Prof. C. Lloyd Morgan.

SOCIETY OF CHEMICAL INDUSTRY, at 8.

TUESDAY, JANUARY 5.

RÖNTGEN SOCIETY, at 8.15.—*Adjourned Discussion*: Localisation of Foreign Bodies by X-Rays.

WEDNESDAY, JANUARY 6.

GEOLOGICAL SOCIETY, at 8.—The Silurian Inlier of Usk: C. I. Gardiner.—Some Observations on Cone-in-Cone Structure and their Relation to its Origin: S. R. Haselhurst.

FRIDAY, JANUARY 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.

GEOLOGISTS' ASSOCIATION, at 8.—The Value of Graptolites to the Stratigraphical Geologist: Gertrude L. Elles.

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THURSDAY, JANUARY 7, 1915.

LEAD POISONING.

Lead Poisoning: from the Industrial, Medical, and Social points of view. Lectures delivered at the Royal Institute of Public Health by Sir T. Oliver. Pp. x+294. (London: H. K. Lewis, 1914.) Price 5*s*. net.

LEAD and its compounds are among the most serviceable of metallic products, but unfortunately their use is attended by a great amount of human suffering, and lead-poisoning, or, as it is variously called, plumbism, saturnism, *Colica pictorium*, or *Colica pictorum*, is one of the commonest forms of industrial intoxication. Nearly every class of worker handling lead or its compounds is liable to be injuriously affected, from the miner engaged in getting cerusite, the smelter, desilveriser, or flue cleaner who are employed in the extraction of the metal; the worker who oxidises it to litharge and red-lead; the type-founder, stereotyper, and diamond-cutter, who use its alloys; the file-cutter, who employs it as a "bed" or "stock" to, of course, the plumber, who, as his very designation implies, is essentially concerned with the applications of the metal in its finished state. And the compounds of lead are as a class even more directly and immediately toxic than the metal. Many of them enter largely into the composition of pigments, and accordingly colour-mixers, house and coach painters, lithographers, as well as those who make the pigments, are prone to suffer from lead poisoning. Lead compounds are used in metal-polishing, in electro accumulator making, in dyeing, glass-making, pottery manufacture, and in the glazing of hollow ware, and cases of plumbism are particularly rife in those industries. Communities are occasionally subject to an epidemic of lead-poisoning, owing to the action of some kinds of drinking-water upon the leaden pipes and cisterns used to convey and store the water.

It is, therefore, scarcely to be wondered at that the subject of lead-poisoning should have received the earnest attention of pathologists and sanitarians, and of the public departments in various countries concerned with the supervision of the hygienic condition of factories and workshops. In the work before us, Sir Thomas Oliver, who has made the subject a special study, and is an acknowledged authority upon it, gives us an admirable digest from the industrial, medical, and social points of view of what is known concerning it.

He deals with the various industries concerned with the use of lead and lead compounds, and the relative frequency among them of lead-poisoning; explains how it is actually caused, the channels of entrance of the poison, and its symptomatology; its action on the blood and nervous system; its influence on female life and motherhood; and lastly, its treatment, preventive and curative. Incidentally he shows the good that has been effected by legislation, and points out the beneficial results that have followed from Home Office inspection and regulations.

The book is primarily intended for the medical profession, but we commend it to the attention of all who are interested in the manufacture and use of lead and its compounds. Lead, of course, is too valuable a metal to be wholly dispensed with, and its good properties are such that it must continue to be used. But there is no question that certain of its more harmful compounds could be dispensed with, as innocuous substitutes are known; *e.g.*, white lead may in many cases be replaced by zinc white, leadless glaze might more often displace lead glaze. But even where used, less harmful compounds than those actually employed are available, as, for example, fritted glazes in substitution for "raw lead glazes" in the manufacture of pottery. Although a certain amount of progress has been made, lead-poisoning in the Potteries is still far too prevalent; the actual number of cases reported may be fewer than was the fact when the Thorpe-Oliver Report to the Home Office was published, but recent statistics indicate that the number of severe cases, ending in death, has shown no sensible diminution. If, then, lead compounds must continue to be used in this industry, it is only by the intelligent appreciation and study of the facts set forth in Sir Thomas Oliver's little book that progress in remedial measures can be secured. T.

VEGETABLE TANNINS.

Die Gerbstoffe: Botanisch-chemische Monographie der Tannide. By Dr. J. Dekker. Pp. xiii+636. (Berlin: Gebrüder Borntraeger, 1913.) Price 20 marks.

THIS book is the German translation of the earlier Dutch edition (1905–8), and is supplemented and revised up to date. The author is specially fitted to write on the subject of vegetable tannins, as he is both botanist and chemist, and has for many years been engaged in research on these bodies.

In the botanical section of the book a classification of the tannins is given, which is far more complete and useful than any previous work of this kind. The excellence of this part of the book is very largely due to the original work of the author and his collaborators. The value of such a survey is obvious not only to the man of science, but to the technical leather trades chemist who is always seeking some new tanning material in view of the probable early exhaustion of some of the materials now in common use. A chapter on the physiological *rôle* played by the tannins in the plant concludes the botanical part of the book, and gives a very interesting account of the work done on this difficult subject.

The researches of Emil Fischer and his pupils on the chemistry of the tannins have robbed the earlier work on the subject of much of its interest, and the author might have gone further in cutting down his account of this older work, which will only rarely bear criticism and is scarcely ever suggestive of further work. This applies even to the formula which the author himself suggested for gallotannic acid,

$$C_6H_2(OH_3).C(OH).O.CO.C_6H(OH)_3,$$

a constitution which is merely the tautomeric form of that suggested by Böttinger for oakwood tannic acid,

$$C_6H_2(OH)_3.CO.C_6H(OH)_3.COOH.$$

This fact is not alluded to by Dr. Dekker, or by other authors who have discussed Dekker's formula.

An excellent bibliography of tannin literature, comprising all books published since 1571, and all papers since 1754, forms one of the most valuable features of the book. All who intend working on the chemistry or chemical technology of tannins will find here a valuable guide to original work on the subject. Dr. Dekker also gives accounts of no fewer than eighty-six methods of tannin analysis. This part of his book is of great interest to leather trades chemists. The same cannot be said of the chapter on practical tanning, which would have been better omitted.

Dr. Dekker's book can be thoroughly recommended to all botanists, chemists, or technologists who are specially interested in vegetable tannins, as it is certainly the best and most complete account existing of our knowledge of these bodies.

E. S.

WIRELESS TELEGRAPHY.

(1) *Text-book on Wireless Telegraphy.* By Prof. R. Stanley. Pp. xi + 344. (London: Longmans, Green and Co., 1914.) Price 7*s.* 6*d.* net.

(2) *Wireless Telegraphy: a Handbook on the Fundamental Principles and Modern Practice of Radio-telegraphy.* By A. B. Rolfe-Martin. Pp. vi + 256. (London: A. and C. Black, 1914.) Price 5*s.* net.

THE literature of wireless telegraphy has already become very extensive although the art and practice of the subject is scarcely more than fifteen years old. Leaving out of account the large number of original memoirs on the scientific side, we can say that broadly speaking the books written on the subject fall into three groups. There are first a few which deal in an advanced manner with the scientific exposition of it, making free use of whatever mathematical analysis may be required, and assuming on the part of the reader a sufficient preliminary acquaintance with physics. Then at the other end of the bookshelf we find a large number of smaller books which aim chiefly at imparting to the amateur or practical operator a knowledge of the use of the appliances and instructions for making or operating wireless telegraph apparatus. An intermediate group of books comprises the student's text-books, which, whilst giving descriptions of apparatus, endeavour to impart a certain degree of explanation of its operation suited to those whose acquaintance with mathematics or physics is limited. The two books before us belong to the latter class.

(1) Prof. Rupert Stanley's book is marked by a certain novelty of treatment and originality in illustrations. He has not been content merely to appropriate diagrams which have done duty already in other books, but has prepared with considerable care diagrams of circuits and schemes of connections of apparatus in which the nature of the magnetic and electric fields is clearly denoted. This feature is of distinct assistance to the student coming to the subject for the first time. Also he has judiciously abandoned the usual practice of describing wireless apparatus arranged under various "systems" ascribed to particular inventors, and has grouped the information in chapters comprising descriptions of particular elements in the apparatus.

The first seven chapters of the book are devoted to an exposition of the elements of electrical and electrical engineering knowledge, to which, however, utility is imparted by basing it on the electronic theory. There is no doubt that this method is a useful one. The student is in this manner enabled to visualise some of the operations better, but the teacher should at the same time be careful to point out that there can be no finality in any of our explanations of Nature's processes. Because we can conceive a mechanism by which the effects we see are brought about it does not in the least degree follow that they are actually done in that manner. A commendable feature of the book is a series of questions at the end of each chapter which will aid the teacher in testing the results of his teaching.

Some of the explanations in the book might with advantage have been amplified. For instance, in the description of Goldschmidt's high-frequency alternator no explanation is given of the reason the non-used lower harmonic frequencies do not dissipate energy to such an extent as greatly to lower the over-all efficiency of the machine. Otherwise the book will prove to be a useful text-book for class teaching for students who come to the subject without much previous knowledge. The book is well printed, and the illustrations are well selected and drawn. The diagram No. 54, representing the lines of electric force round a Hertzian oscillator, is, however, not very true to fact. The loops of force thrown off should be concave on the inner side, and not convex.

(2) The book by Mr. Rolfe-Martin covers much the same ground, but is marked by less originality of illustration and more dependence on diagrams borrowed from commercial publications or magazines than is the case with Prof. Stanley's book. It is also more occupied with descriptive matter of the various appliances used by the Marconi Company, the Telefunken Company, and others. Nevertheless, it is well up-to-date, and for the student who can afford to possess more than one book on wireless telegraphy it is useful to have illustrations of actual apparatus in various forms.

Books which aim chiefly at an exposition of first principles rather than at descriptions of apparatus are likely to have more permanent value because the principles remain, whereas types of apparatus are being perpetually changed. In both of the above-mentioned books the authors have done wisely to discard all reference to early and now antiquated forms of wireless telegraphy. Neither of them, however, devotes much space to the consideration of the problem of radio-telephony.

There is here a wide field yet open for invention. The invention of a simple, easily managed generator of undamped waves and mode of modulating their amplitude in accordance with the wave form of the speaking voice offers a large scope for invention, and one which, if successfully cultivated, may end in replacing radio-telegraphy by radio-telephony to much the same extent as the telephone has replaced the telegraph in the case of wire transmission.

It need scarcely be said that in books intended for students there is no reference made in these publications to the outstanding problems and difficult questions of radio-telegraphy. The mode of propagation of the waves over the earth's surface is, however, dealt with by Prof. Stanley in his tenth chapter in a manner sufficient to impart some ideas of the nature of it as well as of the causes of the variations observed. It is becoming more and more clear that our terrestrial atmosphere plays an important part in long-distance radio-telegraphy, and that if the earth were a good conductor, say, as good as copper, and possessed no atmosphere, anything like long-distance wireless telegraphy on it would probably be impossible.

The progress of real knowledge on this subject will therefore be to a large extent conditioned by the progress of atmospheric meteorology and a knowledge of the state and constitution of the upper air.

J. A. F.

TRANSLATIONS OF POINCARÉ ON METHOD.

(1) *Science and Method.* By Henri Poincaré. Translated by Francis Maitland. With a Preface by the Hon. Bertrand Russell. Pp. 288. (London: Thomas Nelson and Sons, n.d.) Price 6*s.* net.

(2) *The Foundations of Science: Science and Hypothesis; The Value of Science; Science and Method.* By H. Poincaré. Authorised translation by G. B. Halsted. With a special Preface by Poincaré, and an Introduction by Josiah Royce, Harvard University. Pp. xi+553. (New York: The Science Press, 1913.)

(3) *Wissenschaft und Methode.* Von Henri Poincaré. Autorisierte deutsche Ausgabe mit erläuternden Anmerkungen von F. und L. Lindemann. Pp. vi+283. (Leipzig und Berlin: B. G. Teubner, 1914.) Price 5 marks.

(4) *Letzte Gedanken.* Von Henri Poincaré. Mit einem Geleitwort von Wilhelm Ostwald. Uebersetzt von Dr. Karl Lichtenecker. Pp. v+261. (Leipzig: Akademische Verlagsgesellschaft, M.B.H., 1913.) Price 4.50 marks.

DURING his lifetime Henri Poincaré published many articles on the philosophy of science, and these were republished in three books: "La Science et l'Hypothèse," "La Valeur de la Science," and "Science et Méthode." After his death, his "Dernières Pensées" were collected and published in 1913. Of the books under review, (1) gives an English translation of the third of Poincaré's works just mentioned; (2) the first volume of a series on science and education, gives an English translation of the first three; (3) gives a German translation of the third; and (4) gives a German translation of the posthumous work.

Poincaré's lively style is very well reproduced in (1), but in (2) the translation seems to aim at the French spirit, and succeeds in giving an almost comically literal rendering which is not English and not even American. We will reproduce parallel passages of both books to show this. On p. 159 of Mr. Maitland's translation we have:—

"Well, one day I received a visit from M. Hadamard, and the conversation turned upon this antinomy [of Burali-Forti].

"'Does not Burali-Forti's reasoning,' I said, 'seem to you irreproachable?'

"'No,' he answered; 'and, on the contrary, I have no fault to find with Cantor's. Besides, Burali-Forti had no right to speak of the whole of *all* the ordinal numbers.'

"'Excuse me, he had that right, since he could always make the supposition that

$$\Omega = \mathrm{T}' (\text{No. } \bar{\epsilon} >).$$

I should like to know who could prevent him. And can we say that an object does not exist when we have called it Ω?'

"It was quite useless; I could not convince him (besides, it would have been unfortunate if I had, since he was right). Was it only because I did not speak Peanian with sufficient eloquence? Possibly, but, between ourselves, I do not think so."

Dr. Halsted's translation on p. 459 is as follows:—

"Now, one day M. Hadamard came to see me, and the talk fell upon this antinomy.

"'Burali-Forti's reasoning,' I said, 'does it not seem to you irreproachable?' 'No, and on the contrary, I find nothing to object to in that of Cantor. Besides, Burali-Forti had no right to speak of the aggregate of *all* the ordinal numbers.'

"'Pardon, he had the right, since he could always put

$$\Omega = \mathrm{T}' (\text{No. } \bar{\epsilon} >).$$

I should like to know who was to prevent him, and can it be said a thing does not exist, when we have called it Ω?'

"It was in vain, I could not convince him (which besides would have been sad, since he was right). Was it merely because I do not speak the Peanian with enough eloquence? Perhaps; but between ourselves I do not think so."

Of course, Poincaré spoke of "*le péanien*," but this is scarcely a sufficient excuse for Dr. Halsted's translation.

On the other hand, it is rather evident that technical terms presented a difficulty to Mr. Maitland. He translates "*invariant*" by "invariable" on p. 35, "*la théorie des congruences*" by "theory of congruents" on p. 41, and "*implique*" by "involves" on p. 161. Dr. Halsted gives, as we should expect, the correct translations at the corresponding places of his book (pp. 375, 379, 460). It is rather unusual to speak of analytic functions as "analytical functions," as Mr. Maitland does on p. 77; Dr. Halsted uses "analytic" on p. 403. It seems to be confusing to speak of a paper, published by Mr. Russell in the Proceedings of the London Mathematical Society, as a "treatise," as Mr. Maitland does on p. 184. Dr. Halsted has "memoir" on p. 477, but has no reference on his p. 479 to the paper in question, whereas Mr. Maitland has (p. 187). Mr. Maitland carefully speaks of a Frenchman as "M." so-and-so, of an Englishman as "Mr.," and of an Italian as "Signor"; but for Germans he has no regular prefix: we often come across "Mr. Hilbert," and, quaintly enough, on p. 192, "Signor Zermelo." Of greater importance than this is that a formula of Burali-Forti, expressed in Peano's symbols, is wrongly reproduced on p. 157 of (1), owing to the fact that Burali-Forti's symbol "Un" is translated "one," thus giving some colour to Poincaré's mistaken contention that the idea of *one* is used in the very definition of "1." In (2) the formula is correctly reproduced (p. 488).

It does not seem necessary to characterise here Poincaré's philosophical writings: Mr. Russell, in his preface to (1), has done this admirably. All the four books under review will be useful in spreading a knowledge of the lighter works of a truly great man. As is so often the case, a lively and amusing style is here, too, sometimes accompanied by superficiality, and original thoughts by obstinacy. Poincaré's preface to (2) is very welcome at the present time: it lays stress on the fact that there is no reason for wishing the world exclusively impressed with the characteristics of one particular race.

As we might expect, (3), which is the seventeenth volume of the series "Wissenschaft und Hypothese," which contains translations of the first two of Poincaré's works quoted above, is admirably translated and provided with learned and excellent notes by Prof. F. Lindemann.

Finally, (4) is provided with a portrait of Poincaré, and the translation seems well done. The remark that the word "Anzahl" means the same thing as "Mächtigkeit" (p. 108) is wrong, and a title is wrongly spelt on p. 111. A somewhat serious mistake, which appears in the editor's note on p. 124, is the failure, like Schröder's, to distinguish between the notions "is contained in" and "is a member of."

φ.

NEW CHEMICAL BOOKS.

(1) *A First Book of Chemistry*. By W. A. Whitton. Pp. vi+150. (London: Macmillan and Co., Ltd.; New York: The Macmillan Co., 1914.) Price 1*s*. 6*d*.

(2) *An Introduction to the Study of Organic Chemistry*. By Dr. H. T. Clarke. Pp. viii+484. (London: Longmans, Green and Co., 1914.) Price 6*s*. 6*d*.

(3) *Methods of Quantitative Organic Analysis.* By P. C. R. Kingscott and R. S. G. Knight. Pp. xvi+283. (London: Longmans, Green and Co., 1914.) Price 6*s.* 6*d.* net.

(4) *Elementary Household Chemistry, an Introductory Text-book for Students of Home Economics.* By Prof. J. F. Snell. Pp. viii+307. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 5*s.* 6*d.* net.

(1) WE fancy that reviewers of a new book would generally appeal first to the preface to learn the object of its author in committing his ideas to print, then try to discover, especially in an elementary text-book, any originality in the method of treatment or arrangement, and finally read the descriptive part. Taking these points in reference to this little "first book of chemistry," it is interesting and satisfactory to learn that it follows no particular syllabus and so gives the author entire freedom in his method of treatment. Books on elementary chemistry are so numerous that there seems to be little room for novelty either in arrangement, description, or experimental illustration, and we have failed to discover anything intrinsically new; but such experiments as have been selected are simple and suggestive in character, and the illustrations which accompany them are unusually good. The treatment is essentially qualitative and non-theoretical. There is no attempt to impose on a student any immature notion of what chemical changes denote. He studies them in great variety and observes their results. He is troubled with no atomic theory, no symbols, and no equations. He learns a lot of hard experimental facts in the first fifteen chapters, and in the sixteenth and last he obtains a little glimpse into the quantitative relations of the reactions he has examined.

We can conceive of no better introduction to chemistry than this book provides.

(2) The volume has been written to cover the new syllabus of the Board of Education and possibly to meet the needs of candidates for medical examinations in organic chemistry.

In his preface the author points out that there are two distinct and incompatible systems of imparting a knowledge of organic chemistry by means of a text-book, one being based upon the theoretical, and the other on the practical, point of view. Why they are incompatible is not apparent; for every theoretical statement must be built upon an experimental foundation and, to be logical, a clear statement of the experimental part should either precede or at least accompany the theory. For the author, it should be added, assumes that the reader is entirely unfamiliar with the nature of organic substances. To illustrate the author's method, we may refer to the paragraph on page 2, that is, at the very commencement of the book, before any description of an organic substance is given. "Now it has been found that when methane is *treated* with chlorine in diffused daylight, a mixture is obtained of products which contain carbon, hydrogen, and chlorine, together with one which contains only carbon and chlorine. On separating these substances by *fractional distillation* and *analysing* [the italics are the reviewer's] them we find the composition of the various pure constituents may be expressed by the formulæ: CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4."

Without inquiring too closely into how these four substances, one of which is a gas, can be separated by fractional distillation, or how the formulæ can be ascertained by an ordinary analysis, we would point out that the student is left quite in the dark as to the nature of any one of the three operations referred to.

Of the two incompatible systems, it seems preferable to the writer to attempt to memorise the description of a series of experiments, which he can understand and visualise, even if he has not the opportunty of performing them, than to learn by heart the mere names of operations which have not been explained and, in the present case, are incapable of giving the results suggested.

Supposing, however, that a practical course of instruction accompanied or preceded the perusal of this book, so that the student was able to realise the significance of the expressions "treat with" or "react with," which frequently recur, and the practical meaning of the series of equations which fill (without any description of the substances involved) the first eighty pages, the book, though overloaded with formulæ, should be of considerable help in acquiring a knowledge of the structure of a large number of groups of compounds and of equations representing fundamental reactions.

(3) This volume, which has been compiled with evident care by its authors, is of a sound, practical, and useful character, and should commend itself to chemists in general and to organic chemists in particular.

The information here collected is not always easy to obtain, unless the reader has had recourse to the German of Hans Meyer. So far as the writer can judge the methods described are well established and of considerable value.

If one criticism may be offered, it is that the authors give few results of their own individual experience. Such intimate knowledge of detail, as the frequent repetition of an analytical method affords, is invaluable to those who have occasion to employ a new analytical process without previous experience, and adds enormously to the value of the description. For example, a knowledge of this kind would decide which of the three modifications of Zeisel's method here given is the most convenient and trustworthy, and so save the necessity of an elaborate account of all three.

Apart from this and as a compilation and accurate transcript of important methods and of references to original memoirs, the book is eminently useful, and is sure to find a secure place on the library shelves of most organic chemists.

(4) The author's object is to introduce the applications of chemistry to household affairs as early and as often as possible. This has been systematically carried through, yet one feels that the introduction of these household topics are in the nature of a concession to the title rather than an integral part of a scheme for teaching chemistry. The book begins, after the usual fashion, and with the usual doubtful success, by attempting to distinguish between a physical and chemical change. It then passes on to the elements, chemical notation, and the atomic theory, after which, by a curious reversal of the ordinary sequence, the law of definite proportion is discussed. Combustion is followed by an account of fuels, gas burners, and illuminants, and so forth, and about half-way through we come upon organic compounds, soaps, food stuffs, etc., whilst textile fibres, dyeing, and bleaching complete the final chapters.

The book, no doubt, represents an honest attempt to build on a theoretical foundation a superstructure of technical facts and problems more or less connected with our daily life; but this attempt within the limits of a small volume renders the superstructure top-heavy, and the result is that much of the information is superficial, the explanations frequently inadequate and confusing, by reason of their brevity, and the style essentially didactic. We would refer especially to the chapters on the atomic hypothesis, on ionisation, and on the organic radicals, which are mere statements of theory.

These defects are to some extent compensated by many well-chosen experiments and by the excellence of the "get up" of the book, which is embellished by numerous portraits. It should be added that the statements in small print under the portrait of John Mayow are incorrect.

J. B. C.

OUR BOOKSHELF.

Transactions of the Paisley Naturalists' Society. Vol. ii. Lists of Renfrewshire Plants, Macro-Lepidoptera, Fresh-water Fishes, Amphibians, Reptiles, Birds, Mammals, and other papers, with introductory notes by the editor, the Rev. C. A. Hall. Pp. xvi+120. (Paisley: A. Gardner, 1915.) Price 3*s*. 6*d*. net.

A WELCOME sign of the continued vigour of natural history interests throughout the country is the increasing number of regional surveys The last we saw—a few months ago—was from Bournemouth, and now we have one from Paisley. Some of these scientific guides have had their origin in visits of the British Association, others have been due to the enthusiasm of a single individual, and others, like the one before us, express the activity of a local society. The editor leads off with a useful introduction on Renfrewshire as a whole. It might well have been longer, but he tells the reader where to go for further information. In the list of plants by Mr. Daniel Ferguson, the stations have been deliberately omitted as it is one of the main objects of the society to guard the treasures of the county against extermination. Mr. Alexander M. Stewart deals with the Macro-Lepidoptera, Mr. Thomas Malloch with the birds, Mr. Malloch and the editor with mammals, and Mr. Duncan Smith with the fossils in the Paisley Museum. There are also lists of reptiles, amphibians, and fresh-water fishes. While we cannot regard the volume as more than the beginning of the kind of regional survey every county should aim at, we appreciate the industry and carefulness represented in the lists. For future editions we suggest that introduced forms such as the edible frog, the natterjack toad, and the grass snake should not be included in the ordinary list, however clearly it may be noted that they should not be there. With a multitude of names it is difficult to avoid misprints, and it is with sympathy that we call attention to Pel*ius* and Tropidon*atus* on one page. The classification of reptiles is new to us and strange. But these are trifles; the volume is a step in the right direction and a credit to those concerned. We wish for the Paisley Naturalists' Society, which this year attains its majority, a long and prosperous life.

Biology. By Prof. G. N. Calkins. Pp. viii+241. (New York: H. Holt and Co., n.d.) Price 1.75 dollars.

THIS introduction to general biology has a pleasing freshness, a quality difficult to attain in these days of many books. It has necessarily much in common with other good introductions, such as Parker's "Elementary Biology," but it is distinctive. It considers general biology as having to do with fundamental facts and principles—with protoplasm and vitality, metabolism, food and transformations of energy, organic architecture, inter-relations, the curve of life from development to senescence, and, finally, species and the factors in evolution. These are the seven divisions of the book, which aims at providing a foundation suitable for the further study of one or more of the many branches.

Prof. Calkins has selected his material judiciously, and by exercising unusual restraint he has kept his introduction within appropriately small dimensions. His treatment is beautifully clear throughout and he drives his nails home. Only in a few cases, *e.g.* in the last chapter, is the treatment too short to be of great use to the ordinary student, who must always have a certain amount of solid concrete stuff to chew at. We have two or three other suggestions to make—though it is a little like trying to adorn the rose. We have a strong impression that general biology deals with the fundamental principles not of living matter, as the author insists, but of organisms. We do not admire the striking first figure in which Prof. Calkins makes general biology the centre of twelve sub-sciences, duplicated for plants and animals, for the arrangement of these does not appeal to us and we have grave doubts regarding the neurology of plants. There are a few typographical errors, which should be seen to: the function of the "sdnalgs" is immaterial, but Dalton instead of Galton (both in the text and the index) is awkward. These are pin-point blemishes on a work of great excellence, which is sure to be found very useful. Many of the new figures deserve great praise, *e.g.* the stereogram of the earthworm for its utility and the picture of Hydra for its beauty. J. A. T.

Farm Accounts. By C. S. Orwin. Pp. 209. (Cambridge University Press, 1914.) Price 3*s.* net.

As might be expected, Mr. Orwin has made this a very valuable book. Many works on bookkeeping are arid and unconvincing because the transactions described are obviously artificial, but here we come into contact with the actual thing, and feel that the author is writing from large practical experience of farm accounts. The introduction demonstrates that the farmer is a manufacturer, not a merchant, so that his book-keeping should be conducted on the principle of tracing the cost of production right through to the time of sale. Farm valuations are then lucidly explained, and illustrated—as are all the other topics—"from actual accounts kept by tenant-farmers in various parts of Britain." The following chapter on farm records deals with manual and horse labour, foods and manures. Next comes a clear and detailed description of the way books ought to be kept, accounts closed, and the figures used for construction of a profit and loss account and balance sheet. The final chapter sets forth some of the conclusions and deductions that may be arrived at by study of the year's accounts. An index is appended.

The work is primarily intended for use in farm institutes, and should be well within the comprehension of full-time county council students in agriculture, though probably too difficult for short coursers, whose school education has often largely evaporated. The value of the book would be enhanced by the addition of exercises for class work.
J. R. A.-D.

Who's Who, 1915. An Annual Biographical Dictionary, with which is incorporated "Men and Women of the Time." Pp. xxx + 2376. (London: A. and C. Black, Ltd.) Price 15*s.* net.

WE have again to note an increase in the size of this invaluable work of reference. The many excellent characteristics of this annual are familiar to all who take part in the world's activities; and it will be enough to remind readers of NATURE that it contains biographies of distinguished men of science, including, for instance, the fellows of the Royal Society, and those occupying important professorial and professional positions in this and other countries.

Magnetism and Electricity, including the Principles of Electrical Measurements. By S. S. Richardson. Pp. ix + 598. New and revised edition. (London: Blackie and Son, Ltd., 1914.) Price 4*s.* 6*d.*

THE first edition of Mr. Richardson's book was reviewed in the issue of NATURE for December 31, 1908 (vol. lxxix., p. 246), and a description of its chief characteristics was then given. The whole of the text of the new edition has been revised, several portions have been re-written, and a chapter on the principles underlying the action of dynamos and motors has been added.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Appley Bridge Meteorite.

IN NATURE of November 5, 1914, Mr. W. F. Denning gave an account of the meteorite of October 13, 1914, in which he mentions that the object had been found, and was then at the Godlee Observatory, Manchester.

The object which fell at Appley Bridge belongs to the aerolites or stony meteorites, and not to the siderites or irons. In appearance there is the striking meteoric features of deep thumb marks—piezoglyphs—and the general coating a dark brown to black. This was in distinct contrast to the interior, which was of a light grey colour. In general the figure gave one the impression of its being a segment of a spherical shell, the dimensions being:—

Length	9·65 in.
Depth	9·13 ,,
Width or thickness ...	6·62 ,,

The longest diagonal measurement gave 10·76 in.

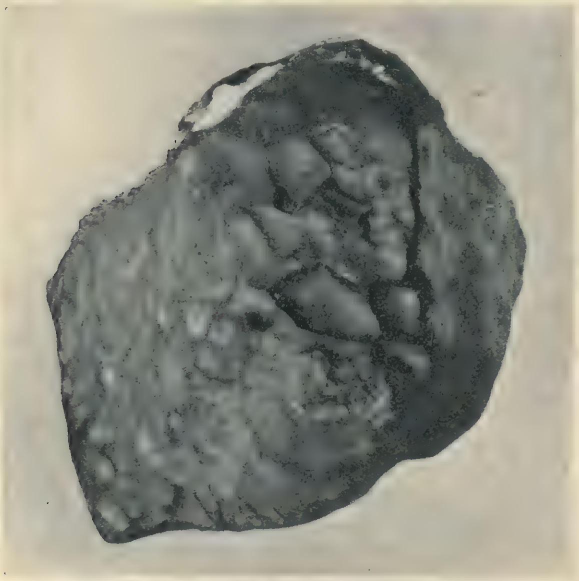
When the aerolite reached the Godlee Observatory, it was in two pieces, weighing 28 lb. 13 oz., and showed evident signs that some considerable portions had been broken away since its discovery.

The very friable nature of the mass was such that portions could be readily broken off by the thumb and fingers, and it is to this softness of texture that its losses are due, as the weight at the time of discovery was given as more than 30 lb.

It is certainly a remarkable object, as on a comparison with the list of meteorites recorded in Great Britain, published in the British Museum Guide to Meteorites, there is only one given of greater weight, that fell at Wold Cottage in Yorkshire in 1795.

The outer coating, which varies from a very thin film to nearly 2 mm. in thickness, presents a very finely-pitted surface, with evidence of a tendency to show lines of movement, as though the heated skin was being pushed backwards from the direction of motion. The portions which had become fused showed a dark glazed or shiny surface, this evidently being the forward end, and the portion to which the heat from the compressed air in front of it was most effective. The appearance of the pittings suggest that the heating of the surface was the means of liberating some portions of the structure of the mass, and that these would provide what is seen as the trail of the meteor after it has passed in its flight through the air, being the continued glow of the heated emissions by combination with the oxygen in the air.

There is evidence that some portions of the surface had only come into contact with the air during the later portion of its traverse. These regions have all the appearance of flakes of the outer skin having been broken away, a slight tarnishing of the pyrites, if at a distance from the edge of the fracture or slight fusing when close to the general outer coating, indicating a removal of portions of outer layers of the mass.



Appley Bridge Aerolite, October 13, 1914.

This is quite in keeping with the assumption that the fragments were split off at the time of the apparent burst in the air, at about twenty miles' altitude, as from that position the speed of the meteor would be so much reduced by the compressional friction, that it would be losing more heat than gaining.

The fractured surface on an inspection appeared to be made up of a glittering mass of white and yellow points in a grey setting. These proved to be chiefly pyrites, and their presence accounted for the apparent great weight according to the size. The specific gravity of the mass determined from a fragment was 3·33, and is in accord with what would be expected from the mineralogical contents. A magnetic examination of the mass as a whole gave no appreciable effect, although a search amongst the dust which accumulated from the rubbing of the two pieces, indicated portions of magnetic nature though small in amount which proved to be metallic iron.

The pyritic material contains nickel as well as iron, portions being crystalline, the olivine being of a pale yellowish-green colour, whilst the enstatite is whitish or grey.

The proportions of the minerals worked out on the basis of the composition and solubility are approximately:—

Pyritic and metallic matter	5·07
Enstatite	31·5
Olivine	63·43

The analysis which has been made by Mr. E. L. Rhead indicate the presence of the following in order of amount:—

Silica	SiO_2	Phosphorus	P
Magnesia ...	MgO	Soda potash	
Iron...	Fe	Chlorine	
Alumina	Al_2O_3	Lime, etc.	
Sulphur	S	With oxygen in combination	
Nickel	Ni		

The accompanying illustration shows the front view of the aerolite with the thumb marks.

WILLIAM C. JENKINS.

11 Upper Lloyd Street, Moss Side, Manchester,
December 27, 1914.

A Suggested Definition of Magnetic "Permanence."

FROM time to time accounts appear of experiments on new kinds of steel which have been undertaken with the object of determining the most suitable material from which to construct a permanent magnet. Experiments of my own on this subject, made a good many years ago, led me to think that it would be an advantage if precision could be given to the term "permanence" in magnetism, and inasmuch as a high coercive force is the principal factor in the preservation of the magnetism in a magnet the measure of *permanence*, I think, might be taken as the *coercive force per unit of residual magnetic intensity*. Thus the inclination of the intensity-field curve as it falls from residual to zero intensity indicates what the permanence of the magnet may be expected to be.

According to this definition the permanence of soft iron is about 0·0024. Recent experiments by Miss Margaret Moir (*Phil. Mag.*, November, 1914) on chrome steel give the high permanence of 0·165, or, if the calculation is made from final residual magnetism after shocks and changes of temperature, of 0·201. These examples show a range of permanence from 0·0024 to 0·201, in the ratio of 1 to 84, but it is not unlikely that these limits may be exceeded.

J. R. ASHWORTH.

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EUROPEAN AERODYNAMICAL LABORATORIES.[1]

IN the summer of 1913 Prof. Zahm and Lieutenant Hunsaker, of the United States, visited the European aerodynamical laboratories in order to study apparatus and methods in use, before finally deciding on the details of the material to be provided by laboratories in America. Prof. Zahm is the Recorder of the Langley Laboratory of the Smithsonian Institution, whilst Lieut. Hunsaker is connected with the School of Technology, Boston. Report No. 2273 is a critical study by Prof. Zahm of European apparatus and methods, but the detailed application of the criticism is still unknown as the re-opening of the Langley Laboratory cannot yet be said to be effective.

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[1] Report on European Aeronautical Laboratories. By Dr. A. F. Zahm. Smithsonian Miscellaneous Collections, vol. lxii., No. 3. (Washington: Smithsonian Institution, 1914.)

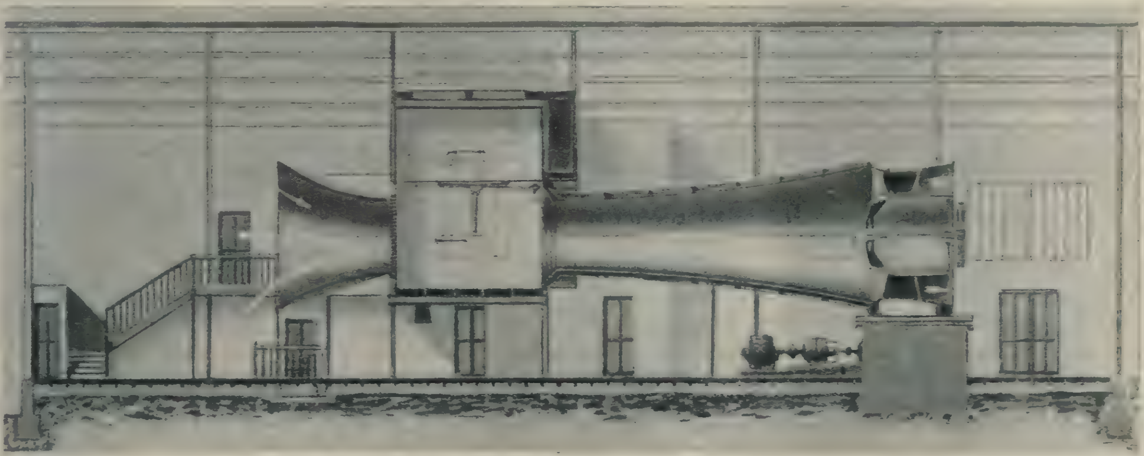

FIG. 1.—Longitudinal section of the large wind tunnel, Eiffel Aerodynamical Laboratory.

The present position appears to be that a scheme of work has been submitted to an advisory board which advocates the provision of a wind tunnel and of facilities for large-scale experiments, and it appears to be intended that the work of the Langley Laboratory should be practically unlimited in its scope.

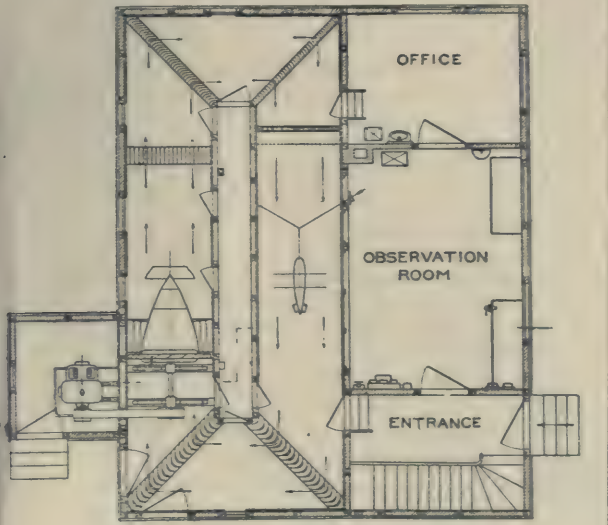

FIG. 2.—Göttingen Aerodynamical Laboratory.

Lieut. Hunsaker is not directly represented in this report, but it is known that immediately on his return to America he proceeded to erect a four-foot wind tunnel similar to that at the National Physical Laboratory, the aerodynamic balance being made for him by the Cambridge Scientific Instrument Co. It is probable that the installation is now in working order in the Massachusetts Institute of Technology.

In his report Prof. Zahm gives brief descriptions of the wind tunnels in Paris, Göttingen, and London, and some of the illustrations in the report are reproduced in Figs. 1, 2, and 3. In M. Eiffel's apparatus the air current traverses the centre of a large room, and one of its advantages is the facility with which models can be moved into and out of the air current. It is further claimed by M. Eiffel that the absence of walls is an advantage in removing some constraint usual in wind tunnels.

In the Göttingen installation, Figs. 2 and 3, air is circulated horizontally through a tunnel containing four right-angle bends, and numerous guide-blades are necessary in order to produce a good distribution of velocity in the working section. Fig. 3 gives some indication of the amount of labour involved in the production of a satisfactory result, and for this reason the writer was informed by Prof. Prandtl that the design would not be followed in a new wind tunnel under consideration.

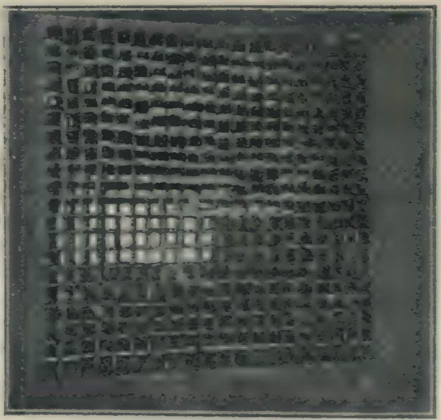

FIG. 3.—Prandtl's honeycomb in wind-tunnel.

The wind channels at the National Physical Laboratory were recently described in NATURE, and little need be reproduced of Prof. Zahm's report. He describes the aerodynamic current as the steadiest in the world with limits of ½ per cent. in both time and space. The steadiness of the air-flow in the Eiffel apparatus is stated to be 2 per cent. in time and space.

Prof. Zahm claims priority for the use of bell-crank balances for aerodynamical work, and says that he is of opinion that several new types can be devised which shall be equally precise with those at the National Physical Laboratory, and probably more expeditious. Such new types have been in contemplation since first devising the bell-crank aerodynamic balance in 1902. It is therefore probable that the balance for the wind tunnel of the Langley Laboratory will be of the bell-crank type, but will differ in detail from those in use in Europe at the present time.

In reference to full-scale experiments, Prof. Zahm considers that the Royal Aircraft Factory most nearly approaches the organisation projected for large-scale work at the Langley Laboratory, though he excludes the possibility of manufacturing aircraft in considerable numbers. He considers the outcome of the large-scale experiments at the Royal Aircraft Factory to be the production of a stable, efficient, and safe biplane. Reports from the seat of war add strong support to this view.

A considerable amount of space in the report is devoted to a description of the apparatus for large-scale experiments at St. Cyr, near Paris, and the remark is made that the relative importance of such large-scale tests as can be carried out on moving carriages, as compared with model tests or full-scale flights with instruments mounted on the aeroplane, has yet to be determined. The difficulties of experiment are indicated by the statement that the lift measurements on simple lifting surfaces are 5 per cent. in error, whilst the resistance measurements are much less accurate.

It is interesting to note that at the time of the visit, no aerodynamical experiments had been made in Germany other than those at Göttingen, but that arrangements were almost completed for large-scale work at Adlershof, near Berlin. For further particulars reference should be made to the original report.

CHEMISTRY OF WHEAT AND FLOUR.

FEWER than ten years ago most millers and bakers would have scoffed at the idea of there being any connection between chemistry and wheat or flour, and even the man of science would have admitted that the application of chemistry to such problems as the cereals presented was in its earliest infancy. Progress, however, has come rapidly and not only is the actual knowledge in the field now very considerable, but it has been already of the utmost value when applied in practice, so that scientific milling as well as scientific baking have made great strides.

It is safe to forecast that chemistry is destined to play as important a part in the manufacture of flour in the future as mechanical science has done in the past, and it is satisfactory to note that there is every indication that Britain is more than prepared to hold her own in this development.

Flour is primarily a starchy material, but those characteristic properties which enable it to be made into bread are due almost entirely to the presence of some 10 per cent. of nitrogenous material—the gluten. Consequently, from the point of view of the miller and the baker, gluten is the all-important constituent of flour. Somewhat irrationally gluten has come to be regarded as such also by the would-be food expert, who overlooks the fact that bread is eaten primarily, not as a source of protein, but as an easily digestible, attractive form of starch. The man in the street properly regards bread as equivalent to rice, potatoes, or the like, rather than as a substitute for meat; it is, therefore, not surprising that the would-be agitators have failed.

Gluten, which is readily obtained from a piece of dough by washing and kneading it in a stream of water until the starch has been removed, is a light brown material which has considerable elasticity.

From the chemical aspect, gluten is a mixture of several proteins, of which two only are of importance so far as its bread-making properties are concerned. These are named gliadin and glutenin, and they are apparently chemical entities so far as this description can be applied to any protein. Gluten is characterised by the properties of ductility and tenacity so that in dough it can entangle air in its cavities, which swell during fermentation and still more when heat is applied.

Wheat grown in different parts of the world is far from being always the same nor does the flour derived from it give the same type of bread. It has long been known that certain types of flour give a large, well-aerated loaf, generally white in colour, and very palatable, whereas other types give a small loaf which is close in texture, dull in colour, and of a stodgy character. Such flours are distinguished as strong and weak and are valued with a difference of several shillings a sack in their price. It has been attempted to express this difference between strong and weak wheats by analysis, and from time to time strength has been correlated with high nitrogen content or, what amounts to the same, a high percentage of gluten, or again to a certain ratio of glutenin to gliadin. Though there is a rough parallelism between strength and these factors, it is in no case absolute, so that no one of them could be said to be the cause of strength. Indeed, the solution of the question has been found in quite another direction.

Gluten prepared from the strongest flour, when carefully cleaned by repeated washing in distilled water, loses its properties; it has neither ductility nor tenacity and partly dissolves in the water.

It acquires these properties again directly small quantities of electrolytes are present, and it is argued, therefore, that the physical properties of gluten are largely controlled by the presence of salts. The analytical study of strong and weak flours, made by Prof. Wood, in following this clue, indicated that the former contained a larger proportion of phosphates: this gave the stimulus to Mr. A. E. Humphries—a practical miller—to try the addition of an extract of phosphates from bran to a weak flour, and when this addition proved advantageous in increasing the strength, the effect of adding small quantities of pure phosphoric acid was tried in its turn. A great deal of painstaking research has been necessary for the elaboration of the new technique of improving flour, and it is now commercially possible to impart the qualities of strength to a weak flour, so that it works better in the dough, has an increased water absorption, and gives a larger loaf of lighter texture, which is more easily digested than when untreated. One result of the treatment, which is of the highest national importance, is that it enables a larger proportion of English wheat to be used in the bread mixture. Notwithstanding all that is said by food reformers and agitators in the daily Press, the public do demand a certain degree of lightness and texture in their daily bread, for which the presence of a considerable proportion of strong foreign wheat in the mixture is essential. This is especially the case in the large manufacturing towns in the North: any sceptic as to the difference can easily make the experiment of comparing the bread from two kinds of flour at his own table.

English wheats as a class yield weak flours, characterised by their excellent flavour. Since they can only be used by the baker to a limited extent they fetch a correspondingly lower price on the market, and to-day are very largely used for household purposes where strength does not matter. The possibility of using a considerably increased percentage of home-grown wheat in the bread mixture is bound to have a favourable effect on the price, the more so as the small country miller can make use of the local supplies near at hand and will be much less dependent on the supplies of foreign wheat, on which he has to pay freight from the ports of entry where the large milling concerns, with which he is in competition, are usually situated. Chemical science has thus rendered a service which promises to be of the utmost importance to the farmer and the country miller.

It is, of course, necessary that a close control should be exercised over the materials allowed to be used as improvers, and nothing but the spraying with soluble electrolytes in minute quantities should be allowed, anything in the nature of loading the flour being strictly prohibited. There is still much prejudice to be overcome against any scientific treatment of wheat, although the baker is allowed free latitude to make the best possible looking loaf from the flour available—an obviously irrational position.

Returning to the scientific aspect of the difference between strong and weak flours, it would appear to be yet another instance of those elusive problems in the chemistry of organic colloids such as are concerned in most physiological problems and most of all in that of life itself. The state of aggregation of the colloid and its susceptibility to this and that alteration, owing to the presence of electrolytes of acidic or basic character, as manifested by changes in the physical properties is a general problem which is engaging the attention of many workers. In the case of flour, sufficient has been done to enable great advances to be made on the purely utilitarian side, though their theoretical explanation may be still veiled in obscurity.

Although strength in flour has been traced as due to the state of the colloid protein brought about by the presence of a certain proportion of electrolytes, our knowledge is still too indefinite to enable the farmer to produce a strong wheat by appropriate manurial treatment. The Cambridge School of Plant Breeders has offered good evidence that strength is a factor in the Mendelian sense, and it is considered possible by appropriate selection to obtain a wheat suitable for English soils which will combine strength with the equally important factors of yield and good straw. The efforts of the Home-grown Wheat Committee to encourage the growth of strong wheats in this country have met with only partial success, because, as a rule, strong wheats give poor yields and inferior straw. Much further research is necessary, which can only be done effectively at agricultural stations, such as Rothamsted, or by the agricultural departments of the universities. The composition of the flour is due to the state of maturation of the wheat berry at the time of harvesting, and it will be valuable to know the strength of the wheats produced on the individual plots at Rothamsted with different manurial treatment.

However, as shown above, the short cut which the miller is able to take renders him much more independent of the nature of his wheat supply, and it is probable in consequence that the considerable difference in price between strong and weak wheats will disappear to a large extent in the near future, so that the incentive to the farmer to grow strong wheats in this country will disappear. That they can be grown has been proved.

E. F. ARMSTRONG.

THE FOOD OF BRITISH WILD BIRDS.

SCIENTIFIC investigations concerning the economic importance of our British wild birds are of comparatively recent date, so that at present the sum total of our knowledge is only limited. To arrive at the precise economic value of each of our commoner species is a task of no mean magnitude, and yet it is slowly but surely being forced upon the minds of all thinking people who are concerned with the produce of the land

and of our fisheries, that such work is more and more becoming a necessity and one also fraught with great possibilities. So clearly has this been recognised by other countries that special State officers devote the whole of their time to the elucidation of the various problems in connection with economic ornithology. If a particular species confers greater benefits than injuries, and we are not affording it all the protection possible, we are pursuing a downgrade and very dangerous course, which cannot fail but produce direct injury to the State.

The subject is a complex one, approachable from many sides, and any investigations, to be of real value, must entail a large amount of careful and detailed work extending over some considerable period of time. The mere cataloguing of the crop or stomach contents of a limited number of specimens of any species, obtained at a particular period from one locality is really of very little value. As the writer has elsewhere stated,[1] "In order to arrive at a proper understanding of the food of any particular species, it is necessary to examine the food contents found in the intestinal tract during the different seasons of the year and from various districts. Further, careful observations must be made in the field, and of the nature of the food brought to the nest by the parents during the breeding season, and also of the fæcal contents extruded from the nest."

We now know that many of the earlier records are either only partially correct or will scarcely bear the interpretation put upon them by their respective authors, for two most important factors have been overlooked, viz., the rate of digestion, and the intestinal food contents found beyond the region of the gizzard. The rate of digestion, according to experiments at present in hand, would seem to vary in different groups of birds; as yet but little work has been done in this interesting field, a more accurate knowledge of which must largely alter our ideas of the various statistical tables which have been given for different species.

Under certain conditions, *e.g.*, during dry summers,[2] a much larger percentage of weed seeds pass through the intestinal canal uninjured, due to the fact that under such climatic conditions a much smaller percentage of grit and soil is taken into the intestinal canal. Thus, observations made upon the grit and soil content in the gizzard of thirty-six rooks during the dry summer of 1911 (June to September) showed that the average content was 108 grains, of which not more than one-sixth was grit, whereas in the same number of birds examined during the wet summer of 1912, the average amount was 214 grains, of which nearly one-third was grit. Similar investigations carried out on the starling and house-sparrow gave an average, in 1911, of 42 and 27½ grains respectively, as against 68 and 53 grains in 1912.

In the past it has been all too readily assumed that those species that feed upon insects and upon weed seeds must be beneficial. We now know that no hard and fast line can be drawn: much careful and extended work is necessary on each individual species before it can be definitely stated that a species is injurious or beneficial.

To the farmer and fruit grower such information is of the greatest import, for at the present moment they suffer enormous annual losses due to certain species of birds.

Of the majority of species of British wild birds, it is generally agreed that they are beneficial, of the remainder the present writer has elsewhere stated that: "Many species which are injurious at one season of the year are distinctly beneficial for the remainder. Again, many birds that are beneficial, may, if allowed unduly to increase, become equally injurious. In other cases the partial failure of their natural food supply, or other causes, may lead to a change in their food habits, in a like manner, the alteration or removal of their natural environment may lead to equally disastrous results."

Although in some districts farmers and others are loud in their complaints of the injuries inflicted, any policy of wholesale destruction would, we believe, be equally disastrous. In nearly all cases, "the misdeeds of birds are much more manifest than the benefits they confer upon us."

With the exception of doves and pigeons, practically all birds feed their young upon an animal diet, whatever the nature of the food of the adult may be, and the bulk of the food consists of insects. These are destroyed just when they are capable of inflicting the greatest possible harm upon our crops and orchards. Further, during the nestling season, the young birds require an enormous amount of food; feeding commences before sunrise and continues after sunset. The starling is known to pay nearly 200 visits to the nest a day, and in the case of the house-sparrow, between 220 and 260 visits daily have been counted. In any attempt, therefore, to estimate the value or economic status of a species, the nature of the food of the nestlings must be taken into consideration.

A careful investigation extending over a period of ten years, entailing an examination of the stomach contents of upwards of 4000 adult birds and 600 nestlings, and numerous observations in the field and laboratory shows that we can classify the commoner species under five headings, viz.:—

1. *Distinctly injurious.*—House-sparrow, bullfinch, sparrow-hawk, wood-pigeon, and stock-dove.

2. *Too plentiful, and consequently injurious.*—Missel thrush, blackbird, greenfinch, chaffinch, starling, and rook.

3. *Injurious, but not plentiful.*—Blackcap.

4. *Neutral.*—Jay.

5. *Beneficial.*—Song thrush, fieldfare, white-throat, great tit, blue tit, wren, goldfinch, linnet, yellow bunting, magpie, jackdaw, skylark, barn owl, brown owl, kestrel, and plover.

The so-called "avian rat," the ubiquitous house sparrow, has probably received more attention from naturalists than any other wild bird, but in spite of all the deprecatory language that has been applied to it, this bird has its redeeming features. It has been allowed to increase to such an extent that it has become one of the worst bird pests we have.

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[1] "The Food of Some British Wild Birds," 1913, p. 7.

[2] *Journ. Econ. Biology*, 1914, vol. ix., p. 69.

In the writer's investigations upon this species, commenced in the early part of 1910 and completed in May, 1914, 404 adult birds were examined and 329 nestlings. Of the former, 207 were shot in or near orchards, 138 in agricultural districts, and 59 in suburban districts. The stomach contents of the birds from the fruit-growing districts showed that the bulk of the food consisted of the caterpillars of injurious insects and weed seeds; in only twenty-three cases were the remains of blossom buds discovered, and in twenty-seven cases wheat grains. There is only one conclusion that we can come to as regards this record, viz., that this much maligned bird is distinctly beneficial in such districts. Unfortunately when we examine the record of 138 specimens from agricultural districts, we find a very different result. Remains of insects occurred on only twelve occasions, whereas wheat grains were found on 115, and the remains of other grains 43 times. The 59 specimens from suburban districts showed a very mixed diet. The stomach contents of the 329 nestlings consisted almost entirely of insect remains.[3]

From the above somewhat exhaustive record it would seem clear that in all agricultural districts sparrows should be given no quarter, whilst in fruit-growing districts and towns they are far too plentiful.

Undoubtedly the worst bird pest the farmer has to contend with is the wood pigeon. Gilmour[4] examined the stomach contents of 265 birds, and stated of the results: "There is no uncertainty, no dubiety about the meaning here: the figures, as given by himself, condemn, and we cannot but convict." The writer examined 388 birds and concluded that there were no extenuating circumstances that would lead him to alter an opinion formed many years back, that no quarter should be shown to it, and that every means should be taken to destroy it.

It frequently happens that when a particular species of bird becomes too plentiful, it changes its food habits, and this, to a large extent, is what has happened in the case of the birds scheduled under this heading. The missel thrush and blackbird have increased enormously in recent years and both have become serious pests to fruit-growers. The damage occasioned by the greenfinch and chaffinch is chiefly to newly sown seed and sprouting corn; both species are too numerous. Each year we hear more and more of the damage done by the starling and the rook. During the past ten or twelve years the former species has greatly increased; such increase being largely due to migration and to the protection afforded wild birds generally. At present it commits a large amount of damage, but if it were considerably reduced in numbers, it would prove, as in the past, a most useful bird.

Numerous investigations on the food of the rook have been carried out, and all have shown that the species is too numerous and consequently injurious. Gilmour[5] examined the stomach contents of 355 birds, Florence[6] 162, Thring[7] 141, and the writer[8] 689.

One regrets to have to condemn such a pretty little summer visitant as the blackcap, but careful observations, extending over eight or nine years, proves that it commits grave havoc in the orchard, and further, it has considerably increased in numbers during this period. Owing to the persecution of the gamekeeper, the jay is, in many districts, annually becoming rarer. Where it is at all plentiful, it undoubtedly steals the pheasant food and the eggs of game birds; it also bites pieces out of rosy-cheeked apples and strips the pods of peas, but it destroys blackbirds and mice, and consumes large quantities of injurious insects and slugs.

In connection with all the species mentioned as beneficial, we should like to see more stringent laws for their protection. It is ridiculous fining the schoolboy for taking a few eggs and allowing the dealer and bird catcher to defy the law.

There is no longer any doubt as to the great value of the barn owl and the brown or tawny owl to the agriculturist, and yet they are destroyed wholesale by gamekeepers and others. Or take the case of the plover. It would be difficult to exaggerate the value of this bird to the farmer. The good it does cannot be over-estimated, and yet the farmers of this country are annually watching its gradual reduction with indifference.

Many species of birds, that otherwise are beneficial, are active agents in the dispersal of weed seeds. In some species the seeds are ground up in their muscular gizzards, but in others this action is so slight that many of the seeds pass through the body uninjured. Thus, such birds as the blackbird, thrush, house sparrow, bullfinch, and greenfinch are now known to be great distributors of weed seeds, and such must be taken into consideration in any attempt rightly to fix their economic status.

Space forbids any reference to such matters as the status of game and sea birds, or the subject of legislation and other means of protecting wild birds, but enough has been said to show how wide is the range of investigation in this important subject. Unfortunately, none of our universities have chairs or departments of economic ornithology, nor is there any adequate aid being offered to the investigator by the State. In common with most scientific investigations, those concerning economic ornithology entail considerable time and expense, frequently beyond the means of the private individual, to whom the work has, thus far, been very largely left. With some State recognition very important results would accrue which would prove of value to agriculture and the fisheries.

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[3] *Journ. Board Agric.*, 1914, vol. xxi., pp. 618–23

[4] Trans. Highland and Agricultural Soc. Scotland, 1896, pp. 21–112.

[5] *Op. cit.*

[6] Trans. Highland and Agricultural Soc. Scotland, 1912, pp. 180–219.

[7] *Journ. Econ. Biol.*, 1910, vol. v., pp. 49–67.

[8] *Ibid.*

WALTER E. COLLINGE.

ATTEMPTS TO MANUFACTURE SCIENTIFIC DISCOVERY.

IN an excellent article forming one of his admirable series of essays entitled "Science from an Easy-chair," published in the *Daily Telegraph* of December 15, 1914, Sir Ray Lankester deals particularly with the case of the recent proposal that the Lister Institute should be handed over to the Medical Research Committee of the National Insurance Commission. The proposal was rejected on November 18 by the votes of the members; and Sir Ray Lankester preaches a useful sermon upon this text. He maintains that men of science "have no confidence in vague invocations of 'centralisation' and 'co-ordination'—abstractions with which Lord Moulton endeavoured to allure them. They do not wish to see the Institute placed at the disposal of centralisers and co-ordinators. The men they desire to maintain in undisturbed control of the Lister Institute are of a totally different class, namely, the rare individuals known as 'scientific discoverers'—a variety of humanity impossible to drive or to co-ordinate, inevitably paralysed by official programmes and stultified by ignorant though well-meaning superintendance." He continues:—

> There is a widespread but erroneous belief in official circles, and among wealthy philanthropists, to the effect that you can hire a scientific discoverer and then say to him, "Discover me this" or "Discover me that" (naming to him a possible and greatly desired piece of new knowledge), and that he will thereupon proceed right away to make the discovery which you want. . . . But valuable and important scientific discovery cannot be produced directly in response to orders given and money expended. You cannot manufacture scientific discovery like soap. The great difficulty, in the first place, is to catch that rare and evasive creature—a scientific discoverer—and when you have found him you have to humour him and let him do as he fancies. Then he will discover things, but probably not the things which either you or he wanted or expected.

All this is very true, and I for one entirely agree. But I think that we should distinguish between *major discovery* and *minor research*. To be frank, the former has been made almost entirely by amateurs, or at least by men who were amateurs when they started; and such discoveries are somewhat rare and depend upon the production by nature of a peculiar and equally rare type of mind. Thus history shows that there are vast nations, consisting of hundreds of millions of people, who never make a scientific discovery from century to century; while, on the other hand, small peoples who appear to be in some favourable biological condition, turn out major discoveries by the score. To me it has always seemed that major discovery is a kind of efflorescence of the human race, occurring only for a brief period in the life of a people. But minor discovery, or rather research, is of another order. It is not of the epoch-making type of major discovery, but is still useful and must not be depreciated. In the present day, when science has advanced so much, this second class of research becomes absolutely necessary for the purpose of filling in the innumerable petty details which go to complete a great scientific theorem; and the difference of opinion which certainly exists regarding the best method of encouraging discovery depends chiefly upon a failure to make this distinction. Thus, when some of us talk of research, they refer only to major discovery, while others refer only to the minor work.

My own opinion is that both should be clearly recognised. The best way to encourage major discoveries is to remove difficulties as much as possible from the path of the unique individuals who make them; and that is why I have always advocated a proper State recognition of such work. On the other hand, minor researches do require a certain amount of organisation—though, even here, great care must be taken not to interfere by too much direction from above; and the question is what kind of organisation is the best. At any rate, most men of science will agree with Sir Ray Lankester when he records a note of objection to "the existence of a Board of Trustees with a Managing Committee, or of any committee playing the part of employers and proprietors towards the men of science who are heads of laboratories in an institution designed for scientific discovery."

Personally, I think that our British notion of constructing such committees chiefly out of "superannuated politicians, retired civil servants, lawyers, medical men, peers, and clerical dignitaries, as well as men who have made fortunes and retired from business," is quite foolish, and indeed improper. But we seem to pursue this habit in nearly everything—the argument being apparently that the men who know nothing about a subject are the best to direct efforts in connection with that subject; so that we appoint lawyers to be heads not only of scientific and learned institutions, but even of the War Office and the Exchequer. In my own humble opinion, lawyers would be much better employed in revising or reforming the mass of confusion (as they themselves admit it is) called law. I do not object to lawyers more than to other amateurs being placed in such positions; but the point is whether research institutions should not be put exclusively under the management of men who have proved their capacity for research by success in it—and only under such. The existing British custom has an unpleasant savour of secret wire-pulling and other methods of acquiring "influence." It would be quite useful, were it possible, to analyse the committees of our few research institutions; but the time has come when men of science should begin to look into all these matters a little more closely than they have done in the past.

RONALD ROSS.

NOTES.

The Royal Society is represented in the New Year's Honours List by Dr. J. J. Dobbie, principal of the Government Laboratories, and Dr. F. W. Dyson, Astronomer Royal, each of whom has received the honour of Knighthood. Sir William MacGregor, G.C.M.G., who retired recently from the Governorship of Queensland, and whose scientific work is well known to geographers and anthropologists, has been made a Privy Councillor. Prof. J. Marnoch, regius professor of surgery, Aberdeen University, has been appointed a commander of the Royal Victorian Order (C.V.O.). Dr. J. H. Marshall, director-general of archæology in India, is among the new knights in the Indian list; while Major S. R. Christophers, officer in charge of the Malarial Bureau of the Central Research Institute, Kasauli, and Mr. Montague Hill, Chief Conservator of Forests, Central Provinces, have been appointed Companions of the Order of the Indian Empire (C.I.E.). Dr. C. A. Bentley, special officer under the Sanitary Commissioner, Bengal, has been awarded the Kaisar-i-Hind medal for public service in India.

It is highly gratifying to be able to record that the board of trustees of the University of Illinois has given the sum of five hundred dollars to the fund inaugurated for the purpose of erecting a laboratory at Rothamsted in commemoration of the centenary of the birth of Lawes in 1814 and of Gilbert in 1817. There has always been a great community of interest between the agricultural experiment stations in the United States and those in this country, and in few branches of science is there better organisation for ensuring that results obtained at any one institution shall be known at the others. Having regard to the fact that the University of Illinois includes such distinguished agricultural investigators as Dean Davenport, Prof. Cyril Hopkins, and others of wide repute, the British workers have reason to be pleased with this practical recognition of the value of the Rothamsted investigations. Although the war has automatically put an end to all attempts to collect money, the fund is now so far complete that only 100*l*. is wanted to make up the 12,000*l*. necessary to build and equip the new laboratory.

Mr. Francis H. Carr, who for sixteen years was chief of the chemical manufacturing operations of Messrs. Burroughs Wellcome and Co., at Dartford, has been appointed to Boots Pure Drug Co., Ltd., Nottingham, with a seat on the board of directors.

We regret to see the announcement of the death, at seventy-one years of age, of Lieut.-Col. D. D. Cunningham, F.R.S., honorary physician to the King, and formerly professor of physiology in the Medical College, Calcutta.

News has been received of the following French geologists and palæontologists:—Jean Boussac, wounded in the foot; Jean Cottreau, in a territorial regiment at Creuzot, well; Robert Douvillé and G. Groth, either killed or wounded; Marius Filliozat, paymaster attached to the Fourth Army Corps, well.

We learn from the *Scientific American* that the American Society of Mechanical Engineers, New York, has awarded the John Frick medal to Prof. J. E. Sweet, honorary member and past president of the society, "for his achievements in machine design and for his pioneer work in applying sound engineering principles to the construction of the high-speed steam engine."

The death is reported, in his sixty-sixth year, of Dr. Albert Charles Peale, who was a geologist in the U.S. Geological Survey from 1883 to 1898. He had since been employed in the section of palæobotany in the U.S. National Museum. In addition to contributions to scientific reports, Dr. Peale's published work consisted mainly of volumes on the mineral springs of the United States.

With the death of Mr. Thomas Bryant, on December 30, there has disappeared the last of the leading British surgeons of the Victorian period. Although in his eighty-seventh year, he still retained the erect carriage and mental vigour of his younger days. When he commenced the study of medicine at Guy's Hospital in 1846, Lister was already in his second year at University College, and the "cell-doctrine" was still in its infancy. Bryant was eminently a practical surgeon, applying himself to the various problems which confronted the surgical leaders of his time. He opened up no new field of surgical endeavour, but he brought an inquiring mind and an industrious pen to help in the general progress of his art. He retired from the surgical staff of Guy's Hospital in 1888, delivered the Hunterian oration in 1893 (having H.M. King Edward VII. in his audience), and served as president of the Royal College of Surgeons of England from 1896 to 1899.

The death is announced of Mr. Henry William Manly, actuary of the Equitable Life Assurance Society, and a distinguished member of the actuarial profession. He completed his third year's examination as an associate of the Institute of Actuaries as long ago as 1867, when he was on the actuarial staff of the London and Provincial Law Assurance Society. He became in due course a fellow, served for several years as one of the honorary secretaries, was elected vice-president, and ultimately became president of the institute in its jubilee year. In all these capacities he took a leading part in its work, contributing many papers to its journal. He was also a prominent member of the International Actuarial Congresses, being the treasurer and secretary for home correspondence of that held in London in 1898. He made the intricate subject of superannuation allowances one of his special studies, and was for that reason consulted by the Royal Commission on Civil Service Superannuation, of which Lord Courtney of Penwith was chairman. It was under Mr. Manly's advice that the new and liberal system of combining life insurance and the provision of a capital sum with the allowance for old age was finally adopted.

We regret to see that one of the pioneers of the Indian Forest Service has just passed away in his seventy-sixth year—Col. J. C. Doveton, of the Madras

Staff Corps, one of the band of military officers selected in the early years of the Department to start work in various provinces. Readers of Capt. Forsyth's charming book, now somewhat forgotten, the "Highlands of Central India," will remember that it was in 1861 that the Central Provinces became a Chief Commissionership under Sir Richard Temple, who took great interest in forestry, so that almost at once he procured the services of Capt. (now Col.) G. F. Pearson as conservator, with Capt. Forsyth and others as assistants. In 1864 they were joined by Doveton, who, on Pearson's transfer, became the conservator, and remained such until his retirement from the service in 1896. During these thirty-two years he devoted himself to the selection and demarcation of forests for permanent reservation and careful management, he studied the welfare not only of the agricultural people, but also of the half-civilised jungle tribes who lived in and near the forests, and he endeavoured to introduce systems of working suitable for supplying the huge amount of small timber and fuel required by the people, and the timbers of better quality wanted for building and railway works. His paper on the growth and cultivation of bamboo in vol. ix. of the *Indian Forester* is still one of the best on the subject. He was a good sportsman, and had a great knowledge of the wild life in the forests, the "atmosphere" of which is now so well known from the wonderful pictures of it in the "Jungle Book."

At the instance of Mr. H. S. Wellcome, the founder of the Wellcome Bureau of Scientific Research, an Ambulance Construction Commission has been inaugurated to consider the improvement of motor ambulances and the standardisation of patterns. The list of members of the commission includes, among other well-known names, those of Sir Frederick Treves, Bart., Sir John Cowans, K.C.B., Sir Arthur May, K.C.B., Sir Alfred Keogh, K.C.B., Sir Claude Macdonald, K.C.B., and Prof. W. E. Dalby. The commission will in the first place act as a judging committee for the award of prizes of the value of 2000*l.* provided by the Wellcome Bureau of Scientific Research. These prizes are offered for the best designs of an ambulance-body which shall fit a standard pattern motor chassis for field motor-ambulances. The last day for the receipt of competing designs is June 30, 1915. It is anticipated that the competition will bring in a number of ingenious designs, from which the ideal field ambulance-body will be evolved. It is hoped that the information obtained by the competition will be published in a permanent form, available for future reference. The first prize is of one thousand pounds, the second of five hundred, and the third of three hundred pounds. All details of conditions may be obtained from the secretary, the Ambulance Construction Commission, 10 Henrietta Street, Cavendish Square, London, W. The competition is open to citizens of all nations.

Record rains for December were registered in London and at other places in the south and south-east of England. At Norwood the aggregate for the month was 6·74 in., the measurement being in strict agreement with the ordinary rules. The Meteorological Office record at South Kensington is said to be 6·60 in., at the Royal Botanic Society's Gardens, Regent's Park, 6·45 in., at Camden Square, 6·34 in., in the City, at Holborn Viaduct, 5·95 in., and at Wandsworth Common, 5·4 in. At Brighton and Torquay the rainfall is reported to have measured more than 9 in., and at Bournemouth 9·8 in. The wettest December previously, according to the Greenwich returns for the past 100 years, is 5·76 in. in 1876, and there are only five instances of 6 in. or more in any month at any period of the year. These abnormal falls are 1828, July, 6·43 in.; 1852, November, 6·00 in.; 1880, October, 7·65 in.; 1888, July, 6·75 in.; and 1903, June, 6·07 in. It will be seen that the rainfall, 6·75 in. in July, 1888, is similar to the amount measured last month in Norwood, and the only monthly fall actually to surpass it is 7·65 in. in October, 1880. The opening days of January have been equally wet, and generally over the metropolitan area the rainfall for the first three days of the month amounts to fully an inch, which is one-half of the usual normal fall for January. It is almost needless to say that these excessive rains are occasioning serious floods in the Thames Valley and over a large part of the country.

In *Bulletins et Mémoires de la Société d'Anthropologie*, Paris, No. 1 for 1914, M. J. Castagné describes a series of stone monuments in Ferghana. They seem usually to take the form of cairns, and the writer is inclined to believe that they were ossuaries in which the ancient inhabitants of the mountains of Ferghana used to deposit the bones of their dead, already picked clean by dogs or other animals, as was the custom in Sogdiana up to the beginning of the seventh century.

The seventh annual report for 1913–14 of the governors of the National Museum of Wales is a record of steady progress. The south block of the new building is under construction at a cost of about 66,000*l.*, and a welcome donation has enabled the governors to proceed with the erection of two additional galleries. Arrangements have been made for the decoration of the building with a series of appropriate sculptures. Though the present is not a good time for an appeal for public support, the governors are naturally desirous of securing funds for the completion of the building. Meanwhile numerous donations of valuable specimens have been made, and it may be hoped that the public spirit of Welshmen, aided by grants from the Treasury, will enable the governors to complete this important building, and to arrange for the display of the valuable collections already in their possession.

Mr. Zae Northrup describes a bacterial disease of the "white grub," or larva of the May or June beetle (*Lachnosterna*, spp.). The organism is a micrococcus which can be isolated and cultivated, and the suggestion is made that it might be employed for the destruction of this larva, which causes considerable depredations among the crops (Technical Bull., No. 18, 1914, Michigan Agricultural College Experiment Station).

To *Naturen* for December, 1914, Dr. A. W. Brögger contributes an illustrated article on certain swords, lance-heads, etc., recently discovered at Haldalsnosi, Hallingdal, and other Norwegian localities, and now exhibited in the Bergen Museum. Six of these weapons are shown in the illustrations to the article.

IN the report of the Clifton College Scientific Society for 1913–14 the want of interest taken on the part of members in the geological class, which had absolutely no supporters, is deplored, as is also the lack of any entries of essays or collections for the Joshua Saunders prize during 1914. The museum is undergoing rearrangement.

IN the *Times* of December 30 appeared an announcement that the London Museum possesses a tooth of a mastodon recently found in the neighbourhood of Southwark. If trustworthy, such a statement would be of great interest, seeing that, with the exception of certain specimens alleged to have come from a Derbyshire cave, mastodon remains are known in this country only from the East Anglian crags. As stated in a letter in the *Times* of January 5, if really found near Southwark, the London Museum specimen must almost certainly be a mammoth's tooth.

IN concluding his experiences of the notes of tropical birds in *Bird-Lore* for November and December, 1914, Mr. L. A. Fuertes takes occasion to record his impressions of the voice of howling-monkeys. After stating that it is not really "howling," according to his conception of that term, he observes that the cry is a hundredfold more "thunderous" and terrible than an animal not much bigger than a large cat could be imagined capable of emitting. Although the party under observation comprised only a male and a female and two half-grown young, "the terrible noise, that issued principally from the throat of the old male, seemed to make the atmosphere quake. . . . The noise was a deep, throaty, bass roar . . . fully as loud as the full-throated roaring of lions."

IN an article in *La Nacion* (Buenos Aires) of Sunday, November 22, 1914, claim is made to the discovery of definite proof of the existence of man in South America during the Miocene epoch. The claim is based on the discovery by Señor Carlos Ameghino, in a deposit in the Chapalmalal stream, on the Atlantic coast of the province of Buenos Aires, of a femur of an ancestral member of that group of ungulate mammals typified by the genus Toxodon of the Pampean, in the shaft of which is embedded part of what is regarded as a flint arrow-head. According to a figure given in the article, this presumed arrow-head is broken short off at the level of the surface of the bone; but no explanation is offered how such a feeble weapon could have penetrated the solid shaft of a bone of the type of a toxodont femur. Other traces of the presence of man are stated to have been obtained from the Chapalmalal beds, which are regarded as immeasurably older than the Pampean formation, in which occurs the so-called "*Homo pampaeus*," and if we accept the views of Señor Ameghino with regard to the embedded arrow-head, it must apparently be admitted that a human being acquainted with fire, and capable of making bows and arrows, lived with the extinct Chapalmalal fauna. Even so, however, this is very far from affording proof that man, in common with the rest of the fauna, was of Miocene age, and in existence prior to the union of South with North America.

A USEFUL contribution to ecological botany is made in the Transactions of the Botanical Society of Edinburgh (vol. xxvi., part iii.), where Miss Lamont gives an account of the ecology of the family estate of Knockdow, Argyllshire. The area of some 6000 acres is largely uncultivated land, and lies mainly on the metamorphic rocks; its overlying soil is peat, and with a flora typical of the western Highlands. On the portion of the area lying on the Old Red Sandstone a slight change in the flora is noticeable, *Galium verum*, *Ononis spinosa*, and *Linaria vulgaris*, for instance, only being found on the Old Red.

THE longevity of seeds is a subject on which specific information is always desirable, and the paper by G. H. Shull, on the longevity of submerged seeds in the *Plant World* (vol. xviii., November, 1914), gives some valuable information on the subject. By the bursting of a dam a lake some seventy years old was drained, and the covering of vegetation, both dense and diverse, which appeared on the dried mud in the following spring, suggested clearly that it arose chiefly from seeds which had been buried for seventy years. The paper describes a series of careful experiments to test the longevity of submerged seeds, which, though only carried on for four and a quarter years in some cases, and nearly seven years in others, show that the vitality of many seeds was fully retained at the end of these periods of time.

THE periodical flowering of the bamboo, resulting in the death of all the plants in a given area, is a well-known phenomenon. The flowering of *Bambusa polymorpha* in Burma is the subject of a communication in the *Indian Forester* for November, 1914, and it is stated that the last time this species flowered in its peculiar extensive manner was in 1859–60. Last year a few clumps flowered, and this year every clump is in full flower. It is of interest to notice that in the year before flowering no new shoots are sent up. The bamboo is regenerated from the seed ripened at these long intervals, hence all the bamboos in a large area are of the same age, and the life-cycle is repeated with regularity. When the bamboo flowers sporadically, as is the case with some species, seeds are not matured, apparently because the bamboo is self-sterile.

A USEFUL and interesting note on fruit-growing in the East Africa Protectorate is contributed to the *Kew Bulletin*, No. 8, 1914, by Mr. H. Powell, who has had about ten years of experience in this subject in various parts of the country. Following the pioneer work, extending over twenty years, by the late Rev. S. Watts, of the N'Gomeni Mission Station, who devoted much attention to establishing European fruit trees, and obtaining, by means of acclimatisation and selection, varieties best suited to the climatic conditions of East Africa, the importance of fruit culture was recognised, and ever since the founding of the Department of Agriculture in 1903 the introduction, cultivation, and distribution of improved varieties of tropical fruit plants have been actively carried on at two experimental stations, while similar attention is being given to temperate and subtropical fruits at a third station. Detailed notes are given regarding a considerable number of fruits and vegetables which have been found to thrive well in different parts of the Protectorate.

The remarkable character of the South African flora is emphasised by Dr. R. Marloth in his recently delivered presidential address before the South African Association for the Advancement of Science, at the meeting held at Kimberley. It is also of interest to note that Dr. Marloth was this year the recipient of the South Africa medal and grant for research, founded by members of the British Association in commemoration of their visit to South Africa in 1905. The adaptation of the vegetative organs of plants to their environment occupies part of the address, and some of the most striking examples are furnished by several species of Mesembryanthemum, Anacampseros, and Crassula. *M. bolusii* and *M. simulans* exactly resemble the singular stones among which they grow, both in shape, colour, and texture. The examples grown at Kew show how stone-like these and other species may be even when grown under glass. The papery-white *Anacampseros papyracea,* which grows among white quartz, is one of the most difficult of plants to detect in its native habitats. *Mesembryanthemum calcareum,* which grows in a lime-tufa region, has the surface of the leaves roughened, exactly resembling the limestone among which it occurs. The colours of some species of Mesembryanthemum and Crassula are also found to vary in accordance with the type and colour of the soil on which they are growing. Examples of this curious mimicry or adaptation in the South African flora might be multiplied, but the explanation of the phenomena is not easy to suggest, and experiment is needed to prove whether, as Dr. Marloth suggests, the light reflected from the soil may be capable of producing a reaction in the plant.

Illustrations of the importance of magnetometric surveys in tracing iron ores are given by Mr. E. Lindeman in papers on the magnetite of Calbogie, Ontario, and on the famous Moose Mountain district, near Sellwood, in the same province (Canada Department of Mines, Mines Branch, 1914). Several detailed maps accompany the latter paper. The geological relations of the iron-bearing rocks at Moose Mountain have been described by Prof. Coleman for the Ontario Bureau of Mines ("Excursion to the Sudbury Area," Guide Book No. 7, 1913); but much remains to be done in distinguishing between the material of igneous origin and the rocks into which both granite and diorite have intruded. The possibility of a sedimentary origin for the Moose Mountain series is by no means excluded, in view of the similar bedded siliceous iron ores of South Africa; and the same may be said of the magnetite of Kiruna, which is commonly cited for comparison. The smoothly glaciated surfaces at Sellwood offer excellent opportunities for study.

To the State librarian of Hartford, Connecticut, we are indebted for a copy of the fourth volume of the Bulletins of the State Geological and Natural History Survey. It is an exceedingly bulky volume, containing half a dozen separately paged bulletins (Nos. 16 to 21), originally published at various dates from 1910 to 1913, four relating to local faunas, and two to the work of the survey. The faunistic papers include (1) the first and second parts of a guide to the insects of Connecticut, by Messrs. W. E. Britton and B. H. Walden, originally published in 1911; (2) an account of the Triassic fishes of Connecticut, prepared, with a section on the study of fossil fishes in general, by Prof. C. R. Eastman, also originally issued in 1911; (3) a survey of the echinoderms of the Connecticut coast, by Dr. W. R. Coe, originally published in 1912; and (4) a systematic list of Connecticut birds, with notes on their habits and distribution, by Messrs. J. H. Sale, L. B. Bishop, and W. P. Bliss, first issued last year. The first three of these publications are fully illustrated.

As the time is now approaching when icebergs and other forms of drifting ice will make their appearance in the North Atlantic, it may be of interest to extract a few of the main facts with reference to the behaviour of the ice in 1914 from the Monthly Meteorological Chart of that ocean for January, 1915, issued by authority of the Meteorological Committee. Icebergs were seen at Belle Isle early in January, and several in 46° N., between 46° and 49° W., with some field ice between January 17 and February 5. On June 17 a berg was passed near 51½° N. and 41° W., and on July 11 another was seen about 46½° N., 40½° W.; these were the easternmost bergs seen up to date of chart (about the middle of December). The loftiest berg of the season was passed near 42° N., 48½° W., on May 19 (estimated at 500 ft. high). On July 27, near 41° N., 67½° W., a small berg was passed; the furthest west in that year. In a very useful article on the subject by Commander Hepworth, C.B. (marine superintendent) in the "Seaman's Handbook of Meteorology," issued by the committee, he shows that icebergs and field ice reach the trade routes earlier in some years than in others; the maximum quantity may be met with as early as April and as late as August. Drifting ice may, it is stated, be observed in almost any part of the North Atlantic north of 30° N. latitude, about as far east of the 10th meridian of west longitude on the eastern side of the ocean, and about as far west as the 75th meridian on the western side, north of 35° N.

In two papers which appeared in the Bulletin of the Bureau of Standards in 1908 and 1912 Mr. W. W. Coblentz described and compared the sensitiveness of the various forms of radiomicrometers. As a result of a series of measurements he concluded that a thermopile with silver and bismuth as its elements gave promise, when used *in vacuo,* of a degree of sensitiveness about half that of a bolometer under the same conditions, while its readings were much steadier. In a further paper reprinted from the bulletin for 1914, he gives details of the methods of construction he has found most suitable for thermopiles to be used in various circumstances. He shows that the attainment of a high degree of sensitiveness is in the first instance a question of neatness of design, and that high thermo-electric power is of secondary importance. For absolute measurements, in order to make the surface receiving the radiation definite in area, he attaches to each junction a small strip of tinfoil, and has already determined the radiation constant σ for black-body radiation by means of the instrument. The result, $\sigma = 5{\cdot}61 \times 10^{-12}$ watt cm.$^{-2}$ degree^{-4}, is about 2 per cent. lower than the value generally given.

The mid-December issue of the Journal of the Institution of Electrical Engineers contained a report on the standardisation of symbols, which has been issued by the International Electrotechnical Commission. Differentiation between italics and ordinary Roman letters is not encouraged, as both appear the same in ordinary handwriting, and "Gothic" type is abandoned. Of course, for the greater part, the old and generally accepted symbols are adhered to, but there are some notable exceptions. For "work" A is recommended, W for energy, and P for power. While t is adopted for temperature, the Continental hieroglyphic which does duty for θ, but has a likeness to the fourth letter of the Greek alphabet as written here, as well as to the partial differential and the printers' reader's deletion mark, is given as a second substitute. The small Greek ω, used here for ohms, is adopted for $2\pi/T$, and in consequence the German practice of designating ohms either by O (a regular trap owing to its similarity to zero) or Ω (which is here employed for megohms) is "provisionally recommended." Other symbols adopted are I for current instead of C, which is allotted to capacity, ϵ for dielectric constant, X for reactance, Z for impedance, and S for reluctance, also a subscript m for maximum values. Arc sin x is to replace $\sin^{-1}x$, the comma or full-stop is to be used for the decimal point, and the comma is to be replaced by a white space for dividing off thousands. Finally, the commission will recommend next year that the name Siemens is to replace the old mho on the rare occasions that a unit of conductance is required.

In the current issue of *Electrical Engineering* there is an interesting article on the transmission of electric power from Sweden to Denmark across the Sound through a submarine cable which will carry current at 25,000 volts pressure. The width of the Sound at this point, namely, between Helsingborg and Elsinore, is only about 3½ miles. Power will be supplied from the network of the South Swedish Power Company, which has several water-power stations, and provision is made for a total power of 5000 kw. to be transmitted to Denmark. This will be utilised for the existing network of the North Zealand Electricity Company, and will include supply to Copenhagen. The case is a typical one for which international transmission should be useful, for, while Sweden has both water-power and cheap coal, Denmark has neither. One cable has already been laid, but it is proposed that it should only be used experimentally at first, and possibly two years may elapse before the Danish network is permanently connected up to the Swedish one. Although this will be the first instance of a submarine supply of electric light and power for industrial purposes between two countries, there have nevertheless been a few other cases of electric power transmission from one country to another. Nancy, Toul, and Verdun get part of their electric power supply from German Lorraine, or at any rate did so before the war, and there is also electric power transmission from Silesia in Germany to Austria, and from the south of Switzerland to Italy. Moreover, the Rheinfelden Works supply current both to the Swiss and German sides of the Rhine.

As mentioned in a recent article (Nature, December 3) the House of Commons' Select Committee on Patent Medicines formulated a number of recommendations as to the enactment of new legislation, and the administration of existing laws, controlling the advertisement and sale of secret remedies. We learn that a committee of the General Medical Council has had these recommendations under consideration, and completely endorses them. One of the proposals is that the administration of the law should be co-ordinated and made part of the functions of a Ministry of Public Health when such a department is created, and that in the meanwhile it should be undertaken by the Local Government Board. With reference to this proposal, the committee in its report urges the necessity for the immediate creation of a Ministry of Public Health. The report has been approved by the General Medical Council.

The publication of the new British Pharmacopœia will be followed closely by several books based upon the information contained in the official work. Three of such to be issued by Messrs. J. and A. Churchill early this year are:—"Materia Medica," fourteenth edition, by Dr. W. Hale White; "The Book of Prescriptions," tenth edition, by Mr. E. W. Lucas; and "The Book of Pharmacopœias," by Mr. E. W. Lucas and Mr. H. B. Stevens, this being a new book containing about 5000 formulas, British and foreign, arranged on a comparative system.

Mr. H. K. Lewis, 136 Gower Street, W.C., announces that the new edition—the sixteenth—of "The Extra Pharmacopœia," by W. H. Martindale and W. W. Westcott, will be published in the course of a week or two. The work will be issued in two volumes, as on the last occasion, and will embody much new matter as well as the necessary revision to bring it into conformity with the new British Pharmacopœia.

OUR ASTRONOMICAL COLUMN.

Bright Meteors of December 29 and 31.—Mr. W. F. Denning reports that fine meteors were observed by Mrs. Wilson at Bexley Heath on December 29, 6h. 59m., and December 31, 11h. 14m. The former was twice as brilliant as Jupiter, and its path was from 94° + 43° to 91½° + 24½°. It was also observed at Bristol and at Essex. The radiant was at 261° + 61°, and height of the meteor sixty-seven to forty-six miles, path forty-four miles, and velocity eighteen miles per sec. The meteor of December 31 was a fireball much brighter than Venus, and its flight was from $324^\circ+67^\circ$ to $350\frac{1}{2}^\circ+55^\circ$, which it traversed in 2 sec. This magnificent object was evidently one of the Quadrantids from a radiant at $228^\circ+54^\circ$. It would be interesting to hear of another observation of it, and also of remarkable meteors reported by Mrs. Wilson as under:—

Date	G.M T.		Mag.	Path		Duration
1914	h.	m.		From ° ′	To ° ′	sec.
Dec. 3	8	7	♀	103+28	109+30	—
5	6	47	♃	20−4	17−6	0·5
	7	14	1	350−20	340−31	2·0
7	8	25	♃	45+17	8+7¾	2·0
15	7	4	>1	64+10	52 0	3·5
16	9	57	>1	64+14½	48+2½	2·0
19	10	3	>1	106+70	133+39	8·0

The last in the table had an extraordinarily slow flight, the duration being carefully estimated as 8 sec.

WATER VAPOUR IN MARS'S ATMOSPHERE.—Lowell Observatory Bulletin, No. 65, contains a paper by Dr. F. W. Very on the intensification of oxygen and water vapour bands in the Martian spectrum. The spectrograms of Mars and the moon were taken by Dr. V. M. Slipher, at the Lowell Observatory, on February 6, 1914, and on the plates taken C, B, and *a* have been measured at the Westwood Astrophysical Observatory, with a spectral band comparator. Each plate contained two sets of spectrograms, and each set consisted of a central Martian spectrum flanked by two of the moon, taken at nearly the same altitude and within a few minutes of each other. By the use of a new stain the photographic sensitiveness of the plate at *a* makes the intensities of *a* more accurate. The observations confirm the supposition that the melting snows of the Martian Arctic regions are the sole source of aqueous vapour in the Martian air, and that the equatorial regions are excessively dry. They indicate also that the actual amount of oxygen in the Martian atmosphere is about half as great as upon the earth.

A SECOND HARVARD MAP OF THE SKY.—Harvard College Observatory Circular, No. 71, contained a description of a photographic map of the entire sky, the map consisting of double contact prints on glass of fifty-five photographs taken with anastigmatic lenses, each having an aperture of 1 in. and a focal length of about 13 in.; the cameras were mounted at Cambridge and Arequipa. Each plate was 8 by 10 in. in size, and included a region of 30° square. The total number of stars shown was 1,683,000, and the limiting magnitude about 11·5. Circular No. 185 now contains an announcement by Prof. E. C. Pickering that a second set of plates has been selected, and another map of the sky has been prepared by Prof. King. In these photographs the centres of the plates coincide with the corners of the first set; this was done as it was found that owing to the large area of the sky covered in the first set the stars near the corners were distorted, and faint stars were not recorded there. The circular contains a catalogue of the plates employed. It is proposed to issue this new set of photographs at the same price as the first, namely, 15.00 dollars—a price, as is stated, somewhat less than cost.

THE SHORT-PERIOD VARIABLE, SZ TAURI.—An investigation of the light curve of the short-period variable, SZ Tauri, is contained in the Harvard College Observatory Circular, No. 186, and was made by Miss Leavitt. Prof. Schwarzschild, in 1911, published the elements of this variable, basing them on observations by Prof. Hertzsprung, and the times of minima were found to be represented by the formula, J.D. 2,418,724·16 M.E.Z.+3*d* 1484 E. It was with the object of securing a more precise period that the present investigation was undertaken, and 210 plates taken at the observatory between October, 1891, and February, 1914, have been utilised for this purpose. A table is given showing all the observations of the variable used, and a curve is added indicating the nature of the light variation. By reducing the observations by the above formula it was found that those previous to 1903 were not satisfied. They were, however, all well represented by the formula for times of maximum, J.D. 2,410,000·60 G.M.T.+3*d* 1487 E, and this has been used in computing the epochs and phases given in the above-mentioned table.

ONE HUNDRED NEW DOUBLE STARS.—Dr. R. G. Aitken, in the Lick Observatory Bulletin, No. 264, gives the twenty-third list of double star measures, the present one containing one hundred new double stars. The mean results of his measures are arranged in the same form as his earlier lists. The angular separation of the pairs ranges from 0·17″ to 4·78″.

PRIZE AWARDS OF THE PARIS ACADEMY OF SCIENCES FOR 1914.

Geometry.—The Francœur prize to A. Claude, for the whole of his astronomical work, and the Poncelet prize to M. Lebesgue. The Grand prize of the mathematical sciences was not awarded.

Mechanics.—The Montyon prize to Ed. W. Bogaert, for his memoir on the gyrostatic effect and its applications; the Henri de Parville prize between Jean Rey (1000 francs), for his work in mechanics and electromechanics, and Marcel Biver (500 francs), for his pamphlet on a system of transmission and transformation of movement. The question proposed for the Fourneyron prize, the theoretical and experimental study of the question of combustion or explosion turbines, is postponed until 1917, as no memoir was received.

Astronomy.—The Lalande prize to J. N. Guillaume, for the whole of his astronomical work; the Valz prize equally between Pierre Salet and Stanislas Chevalier; the Janssen prize to René Jarry-Desloges, for his studies on the planets, especially Mars; the Damoiseau prize to M. Gaillot, for improvements in Le Verrier's tables of Jupiter. No award was made of the Pierre Guzman prize.

Geography.—The Tchihatchef prize between Commandant Audemard (2000 francs) and Paul Labbé (1000 francs), the former for his hydrographical work in China, the latter for his work in Asiatic Russia in the fields of natural history, anthropology, and ethnography; the Gay prize to R. de la Brosse, for his hydraulic studies in the Alps; the Binoux prize between Ernest Esclangon (1500 francs), for his observations on the acceleration of gravity in the south-west of France, Alfred Vialay (500 francs), for his contribution to the study of the relations existing between the atmospheric circulation, atmospheric electricity, and terrestrial magnetism, and Paul Schwartz and Fernand Villatte (500 francs jointly), for the whole of their work; the Delalande-Guérineau prize to Jacques Liouville, for his work in the Antarctic regions.

Navigation.—The extraordinary prize of the Navy is divided between M. Roussilhe (2000 francs), for his works on the French Congo, M. Poincet (2000 francs), for his studies on the association of screw propellers and turbines, M. Crémieux (1500 francs), for his work on the powders of the Navy, and M. Lafon (500 francs), for his memoir on naval and military aeronautics (France and abroad); the Plumey prize between M. Dumanois (2000 francs), for his memoir on the application of the internal-combustion motor to warships, M. Moritz (1500 francs), for his work on thermal motors in their relations with thermodynamics, and M. Schwartz (500 francs), for his work as a whole.

Physics.—The Hébert prize to M. Mauduit, for his treatise on electric machinery; the Hughes prize to Louis Benoist, for his researches on the X-rays; the L. La Caze prize to Jean Perrin, for his work on the kathode rays, X-rays, and Brownian motion; the Victor Raulin prize to Mme. Marchand.

Chemistry.—The Jecker prize to Marcel Delépine, for his work in organic, inorganic, and general chemistry; the Cahours prize to MM. André Meyer and Vavon (in equal parts); the Montyon prize (unhealthy trades) is not awarded; the La Caze prize to M. Debierne, for his researches on the radio-active elements.

Mineralogy and Geology.—The Fontannes prize to Jean Boussac, for his memoir on the evolution of the Cerithideæ in the mesonummulitic of the Paris basin.

Botany.—The Desmazières prize to MM. de Istvanffi and Palinkas, for their study of the mildew of the vine, a mention being accorded to M. Bruchmann; the Montagne prize divided between M. Sauvageau (1000 francs) for his monograph on the Cystoseira, and M. Coppey (500 francs), for his bryological researches; the de Coincy prize to M. Gard, for his studies on hybrids of Cistus.

Anatomy and Zoology.—The Savigny prize to J. M. R. Surcouf; the Cuvier prize to M. Bordas, for his anatomical researches; the Thore prize to J. Feytaud, for his researches on ants.

Medicine and Surgery.—Montyon prizes (500 francs each) to H. Bierry, for his works on the glycogenic function, Ch. Nicolle, L. Blaizot, and E. Conseil (jointly), for their works on the etiology and prophylaxy of recurring fever, and E. Pinoy for his researches on the pathogenic fungi. Mentions, 1500 francs each, to Ed. Delorme, for his memoir on the direct surgical treatment of cardo-pericardiac symphysis, E. Maurel, for his work on alimentation and nutrition in normal and pathological states, and P. Chaussé, for his work on tuberculosis. Citations were accorded to André Broca, for his book on infant surgery; Robert Picqué, for his practical treatise on surgical anatomy and operative medicine; M. Roussy, for his book on five original methods for measuring the surface of the skin of the human body; M. Aynaud, for various memoirs on the question of the third element of the blood; M. Brunon, for his works relating to tuberculosis; MM. Gautrelet and Laubie; and M. Couvelaire, for his introduction to uterine obstetrical surgery; the Barbier prize in equal parts between H. Carré, for his memoirs on contagious agalaxy of the kid and goat, and Albert Ranc, for his studies on the physiological action of light; the Bréant prize between H. Vincent (3000 francs), for his works on the typhoid bacillus and on typhoid fever, and O. Arnaud (2000 francs), for his work on cholera in the Greek army during the Balkan war; the Godard prize to Antoine Lacassagne, for his studies on the action of the X-rays on the ovary; the Baron Larrey prize divided equally between Dr. Reverchon, for his medico-military studies on the second Balkan war, and H. Billet, for his work on the treatment of skull wounds caused by small projectiles; the Bellion prize between M. Gorini (1000 francs), for his work on vaccines, the bacteriology of milk, and pathogenic micro-organisms, and M. Marotel (400 francs), for his researches on parasitic diseases, Raoul Dupuy receiving an honourable mention for his memoir on backward children and their treatment; the Mège prize to M. Bruntz, for his researches on the excretory organs of vertebrates and invertebrates.

Physiology.—The Montyon prize (experimental physiology) to A. Mayer and G. Schæffer (jointly), for their work on the lipocytic coefficient; the Philipeaux prize to Pierre Girard, for his researches on electrical osmosis; the Lallemand prize between Henri Piéron and René Legendre (900 francs jointly), for their memoir on the physiological problem of sleep, and J. Mawas (900 francs), for the whole of his work on the anatomy and physiology of the nervous membrane of the eye in vertebrates and in man, André Barbé being accorded a mention; the Pourat prize is not awarded; the La Caze prize (physiology) to E. Gley, for the whole of his work; the Martin-Damourette prize between M. Fauré-Fremiet (1000 francs), for his memoir on the germinative cycle in *Ascaris megalocephala*, and A. Lanzenberg (400 francs), for his work on ammonia and urea: origin, methods of estimation.

Statistics.—The Montyon prize to René Worms, for his studies on sexuality in French births and on agricultural associations.

History of the Sciences.—The Binoux prize is not awarded.

General Prizes.—A Berthelot medal to M. Debierne; the Gegner prize (2000 francs) to J. H. Fabre; the Lannelongue prize between Mme. Cusco and Mme. Rück; the Trémont prize to Charles Frémont; the Wilde prize between Perrier de la Bathie (3000 francs), for his geological explorations in Madagascar, and M. Schulhof (2000 francs); the Lonchampt prize to M. Javillier, for his work on the biological properties of zinc salts; the Saintour prize between R. Bigeard and H. Guillemin (1500 francs jointly), for their work on fungi, and J. Révil (1500 francs), for his geological work; the Henri de Parville prize between M. Berget (1000 francs), M. Houllevigue (1000 francs), M. Joubin (1000 francs), M. Altermann (500 francs), and M. Coupin (500 francs); the Houllevigue prize to M. Vershaffel; the Caméré prize to Augustin Mesnager; the Jérome Ponti prize between Henri Bröllemann (2500 francs), for his work on the Myriapods, and M. Pelourde (1000 francs), for his researches on plant palæontology; the Serres prize to A. Prenant, for his work in histology, cytology, and embryology; the Jean Jacques Berger prize (15,000 francs) to the Marquis de Vogüé, for the military hospital organised by the institute; the prize founded by the Marquise de Laplace to M. Sasportès; the prize founded by Félix Rivot between MM. Sasportès, Lévy, Jeannin, and Pélissonnier; the Bordin and Henri Becquerel prizes are not awarded, and the Gustave Roux prize is postponed to 1915.

ECONOMIC GEOLOGY IN THE UNITED STATES.

We have received from the United States Geological Survey a number of bulletins dealing with economic geology, namely:—"Reconnaissance of Oil and Gas Fields in Wayne and McCreary Counties, Kentucky," "Oil and Gas in the Western Part of the Olympic Peninsula, Washington," "The Ore Deposits of North-Eastern Washington," "Mining Districts of the Dillon Quadrangle, Montana," "Electric Activity in Ore Deposits." The first two of these possess merely a local interest; the same is true to a large extent of the two next on the list, though their perusal will well repay the students of mineral deposition, more especially in the case of the bulletin on the Dillon Quadrangle, which is from the pen of Mr. Alexander N. Winchell. The last pamphlet contains an interesting study of the possible modes of development of electromotive force in ore deposits and of some of its effects, amongst which latter the deposition of the precious metals in the metallic state by electrolytic action is perhaps the most interesting. It is worth while to direct attention to a sentence in the preface by Mr. George Otis Smith:—"It should be emphasised that the results thus far obtained afford no adequate basis for any method of electric prospecting nor any promise of the development of such a method by connecting the presence of ore deposits with readily or definitely measurable electric activity." Although no very definite results are recorded in this bulletin, it contains much suggestive material, and will probably lead to a fuller investigation of the subject.

We have also received a series of pamphlets dealing with the mineral production of the United States for 1913. In order to enable this information to be issued with the least possible delay, each chapter is issued separately as soon as the necessary statistics shall have been prepared, instead of waiting as heretofore until the whole of the statistical information needed for the entire volume was available. This system not only enables the various chapters to be issued more promptly but enables a producer to whom the statistics of one or of a limited number of substances alone are of importance to concentrate his attention on these and to find what he needs in a handy little pamphlet instead of having to deal with a bulky volume. The chapters hitherto published are—

Part i., "Metals":—(1) Bauxite and aluminium; (2) chromic iron ore; (3) gold, silver, copper, and lead in South Dakota and Wyoming; (4) manganese and manganiferous ores; (5) recovery of secondary metals. Part ii., "Non-Metals":—(1) Mica; (2) fuel briquetting; (3) sand-lime brick; (4) sulphur, pyrite, and sulphuric acid; (5) mineral paints; (6) slate; (7) potash salts; (8) fuller's earth; (9) cement industry; (10) feldspar; (11) talc and soapstone; (12) barytes; (13) silica; (15) abrasive materials; (16) phosphate rock; (19) sand and gravel.

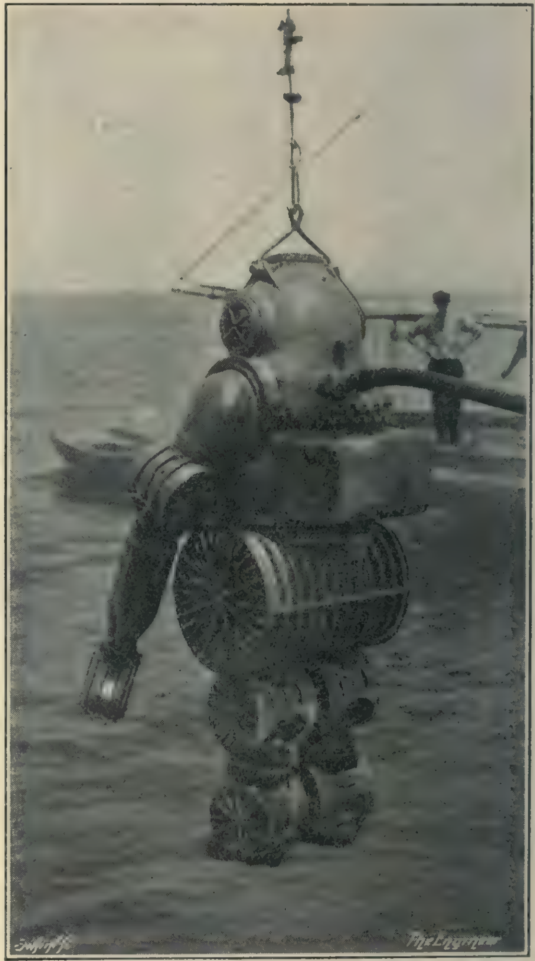
It need scarcely be said that the high standard of accuracy, and abundance of detail, that we are accustomed to find in the statistical publications of the United States Geological Survey have been fully maintained.

IRON IN ANCIENT INDIA.

BULLETIN No. 12 of the Indian Association for the Cultivation of Science contains an interesting article on iron in ancient India, by Mr. Panchanan Neogi, professor of chemistry in the Rajshahi College, Bengal. The author discusses the question whether iron was known in the Vedic age, and advances evidence, chiefly based on the Rigveda, in favour of the view that iron was known and used between 2000 and 1000 B.C. Whether absolute reliance can be placed on this evidence, especially as to the dates, may be open to question, but the find of ancient iron weapons on a burial site in Tinnevelly proves that iron was undoubtedly known in India in very early times; while the piece of iron slag unearthed at Bodh-Gaya shows that iron smelting had been carried on in the third century B.C., and the iron clamps found in a temple on that site, to which the date 400 to 600 A.D. has been assigned, bear evidence to a considerable advance that had then been made in the working of the metal. As regards the metallurgy of the metal, wrought iron was produced, as in all countries in early times, by the direct process from ores by smelting them in small blast furnaces without the intermediate production of cast-iron. The well-known iron pillar near the Kutub Minar, Delhi, and the rectangular iron beams of the temple at Puri, to which the dates 640 A.D.–1174 A.D. have been ascribed, are cited as examples of the scale on which iron forgings were made and of the remarkable skill attained by the workers in the metal. These gigantic forgings were constructed by welding together small blooms of iron, a method which continued to be practised in China and Japan until the middle of last century. The Delhi pillar has not rusted to a marked degree, and this resistance to corrosion is ascribed by the author to the composition of the iron, which is free from manganese and sulphur, and contains a tolerably high percentage of phosphorus. The paper also includes an interesting account of the method of making wootz or Indian steel as practised in India long prior to the manufacture of crucible steel in Europe.

AN ALL-METAL DIVING DRESS.

THE *Engineer* for December 11 contains an account of an all-metal diving dress invented in the United States of America by Mr. Chester E. Macduffee. This dress is the result of about five years' experiment, and is now claimed to have reached a practical stage.



Macduffee Diving Dress. Diver coming up after submergence.
From the *Engineer*.

Divers have used this armour at a maximum depth of 212 ft., and could have gone deeper had more water been available. The dress is made of an aluminium alloy of great strength, and weighs empty about 480 lb.; its very considerable displacement gives it a good deal of buoyancy when in the water, and necessitates the addition of lead ballast. The suit consists of a series of articulated sections having sliding or rotating joints, sealed sufficiently by means of leather and rubber packing; there are fifty-six of these flexible joints. Roller bearings working upon steel rings prevent jamming of the joints under high water pressure. The various parts of the suit are strengthened by internal and external ribbing. The diver in the Macduffee armour breathes air at ordinary atmospheric pressure, no matter how deep he goes, and this differentiates the new suit from the ordinary flexible diving dress. Every part of the diver is enclosed, and this necessitates the addition to the dress of ingenious mechanical hands operated from the interior of the dress. Dangerous accumulations of water due to leakage are dealt with by means of a small pump attached to the dress and worked by compressed air; suction pipes lead from the pump to each foot.

GEOPHYSICAL MEMOIRS.[1]

THE reproach has frequently been levelled at meteorologists as a class that they are almost entirely devoted to the accumulation of masses of undigested and possibly indigestible data, but the aptness of the reproach has been steadily modified of late years, and one of the chief agencies in this country in producing this modification has been the activity of the reconstituted Meteorological Office, under the directorship of Dr. Shaw. When he was awarded the Symons gold medal by the Royal Meteorological Society, one of the grounds specifically mentioned as influencing the council in making the award was Dr. Shaw's capacity for suggesting fruitful lines of research for other people, and the memoirs contained in the volume now being completed bear testimony to this contention.

About ten years ago Dr. Shaw instituted fortnightly meetings during the winter session at the Meteorological Office, to which he invited people interested in meteorology and kindred subjects, and at which definite work on such subjects was discussed and freely criticised in an informal manner, and among the regular attendants at these meetings for some time past has been Mr. J. Fairgrieve, who, having sufficient spare time, amid scholastic duties, undertook the investigation which forms No. 9 of the Geophysical Memoirs. It is to be hoped that his example will be freely followed. No. 10 is a more strictly "office" production, being the continuation of No. 1, in which the superintendent of the Department of Marine Meteorology discusses the effect of the Labrador current year by year upon the surface temperature of the Atlantic and upon the meteorology of the British Isles.

It must be admitted that a considerable proportion of meteorological data is scarcely available for discussion, so that the first duty of the investigator is to sift his material and try to introduce homogeneity. For this reason pioneer work such as Mr. Fairgrieve's "On the Relation between the Velocity of the Gradient Wind and that of the Observed Wind," in which the data are numbers estimated on the Beaufort scale, is the more valuable, in that future investigators are given precious hints as to what to avoid, and observers may take notice of directions in which the form of their data can be improved. The conclusions are encouraging, and the plates of illustration interesting, although the most obvious deduction from them is simply that sea-winds predominate at coast stations, which is scarcely novel. It is evident that more work of the kind is needed, and equally evident that on this subject, as on many others, the proportion of chaff among the available data is inconveniently high. There is a valuable introductory note by Dr. Shaw, who takes the opportunity to print some tables of great wind pressures and velocities at the British stations in the twelve years 1899–1910.

W. W. B.

THE ARTIFICIAL PRODUCTION OF VIGOROUS TREES.

IN an article on the artificial production of vigorous trees, contributed to the Journal of the Department of Agriculture and Technical Instruction in Ireland (No. 1, October, 1914) Prof. Augustine Henry discusses the nature of species, varieties, races, sports, and hybrids, as they appear to be from his researches. Natural species, in the case of trees, are readily recognised by the occurrence of each in a definite region or habitat. We have thus one species of silver fir in Central Europe, another in Algeria, a third in southern Spain, etc. Of our common trees—oak, birch, and elm—there are pairs of species in the same region, each, however, occupying a different habitat, one species adapted to a dry situation, the other suited to a moister soil. The pedunculate oak is a native of valleys and alluvial flats. It is not protected against evaporation of water, the supply of which in the ground it prefers being always ample. The sessile oak is a native of hilly and rocky districts, where water is not abundant in the soil. Its leaves are covered beneath with hairs, which guard against excessive loss of water by transpiration in windy weather. Similarly two alders exist on the Continent, but only one species, *Alnus glutinosa*, reached our islands, after the retreat of the ice sheet, and before the land connection with France was severed by the formation of the Straits of Dover. The other species, *A. incana*, grey alder, is absent from our native flora, but when introduced is very hardy, and is useful for planting in low-lying situations liable to spring frosts. The ash requires such special conditions of soil, that only one species exists in Northern and Central Europe, there being no suitable soil for a second species to inhabit.

A natural species is often a set of individuals uniform over a large area; but it may consist of two or more "geographical varieties," which correspond with distinct territories, each marked by slight differences of foliage, etc., that render the variety better fitted for its own habitat. Thus the Corsican and Austrian pines are closely related, but the latter keeps its leaves two years longer on the branches, so that the dense shade of its abundant foliage preserves moisture in the crevices of the hot limestone rocks, on which it grows in its Austrian and Servian home. The Corsican pine, with half the foliage of the other tree, thrives on granite soil in the moist insular climate of the mountains of Corsica. These two pines —only notably distinct in one character, the amount of their foliage—are usually regarded as two geographical varieties of the same species, *Pinus Laricio*, but by some botanists are considered to be two distinct species.

In a species apparently uniform over a large area there may exist varieties, characterised by minute and scarcely describable differences. This is exemplified by the Scots pine. Plots of its seedlings, raised from seed of trees in the forests of Scotland, Russia, Switzerland, etc., differ in vigour and in other respects (immunity to certain fungi, etc.), when all are grown together under identical conditions. Such varieties, with slight differences of structure, may be called races, and are of great practical importance in forestry. Only seeds of the best race, that is, from vigorous trees of the most suitable locality, should be used.

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[1] Meteorological Office. Geophysical Memoirs. Vol. i., Nos. 9 and 10, completing the first volume. No. 9. On the Relation between the Velocity of the Gradient Wind and that of the Observed Wind. By J. Fairgrieve. Pp. 189–207.

No. 10. The Effect of the Labrador Current upon the Surface Temperature of the North Atlantic, and of the latter upon Air Temperature and Pressure over the British Isles. Part ii. By Commander M. W. C. Hepworth. Pp. 211–220. (London: Meteorological Office, 1914.) Price 1*s.* and 8*d.* respectively.

A sport is usually a solitary phenomenon, arising either as a sporadic peculiar seedling from a seed, or developing out of a bud on a tree as a single branch with some peculiarity of twig or leaf. A sport may be looked upon as a freak, not forming the starting point of a new species, but speedily becoming extinct if left to nature. Sports, when of interest on account of the curiosity or the beauty of their appearance, are propagated usually by grafts, cuttings, or layers; being only in rare cases perpetuated by seed. Some sports are due to arrested development. The tree, in the course of its life, often passes through stages, like those of an insect. The seedling of many species differs from the adult tree as a larva from a butterfly. The infant ash has simple leaves. The sport known as the simple-leaf ash is simply a seedling ash, which has never progressed to maturity and may be called a persistent larval form (Fig. 1).

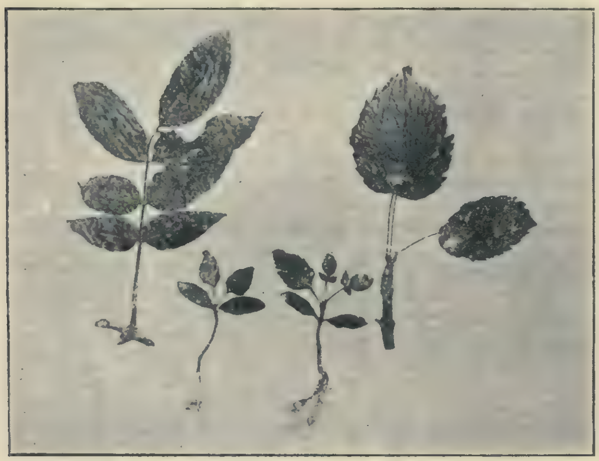

FIG. 1.—Adult foliage of common ash on left, of simple-leaf ash on right; two ash seedlings in the middle, showing primary leaves above the pair of cotyledons.

Abnormal colouring of leaves, so-called variegation, is a sport, usually starting as a solitary branch on an otherwise normal tree, which, when noticed, is propagated by grafting. Deeply-lobed, crumpled, pitcher-like, and other abnormal leaves occur in many species, and are propagated as curiosities. In sports, reversion is often seen; thus on a fern-leaf beech one or two branches with normal leaves are not uncommon. This reversion may be due to the influence of the stock, as these sports are usually grafted; or it may be explained as the triumph locally of normal over abnormal factors. Such reversions are never seen in hybrid trees. The occurrence of a sport seems to predispose to further sporting; a tree with leaves abnormal in shape will sometimes take on, in one branch, abnormal colour as well. These double sports are common in the holly.

Hybrids are combinations of two species or of two varieties, which arise either in the wild state or in cultivation. They are met with in nature as rare individuals on the boundary line between the areas occupied by two species. This is well seen in Yorkshire, where a hybrid oak is found in the localities in which the sessile oak of the hills comes in contact with the pedunculate oak of the valleys. Hybrids arise frequently in nurseries, gardens, and parks, where several species are cultivated together.

Hybrid trees are more common than has been supposed. Many valuable trees, the real history of which has not been suspected by botanists, are of hybrid origin. As an example, may be mentioned the fine elm, which is universally planted in Holland and Belgium, where it is known as *orme gras* or *Ulmus latifolia*, Poederlé. This is not, as sometimes imagined, a natural species peculiar to those countries. It is unquestionably a hybrid, which is invariably propagated by layers, all the individual trees on this account being uniform in appearance. It seems to have originated three or four centuries ago, probably as a single seedling, which has given rise by vegetative reproduction since to millions of descendants.

The distinction between sports and hybrids is well known in the numerous so-called "varieties" of the holly (Fig. 2). Some are sports of *Ilex Aquifolium*, our native holly; others are hybrids, one parent being the common holly, whilst the other is either *Ilex Perado*, which was introduced from Madeira in 1760, or *Ilex Balearica*, the holly of the Balearic Isles, which was cultivated at Versailles in 1789. Miller, in his account of the hollies in 1750, was acquainted only with the sports, which had arisen from the common holly, as the other species had not been introduced at that time and hybridisation was impossible. The hybrids originated soon after 1800, the earliest apparently being *Ilex Hodginsi* and *Ilex Hendersoni*, which were found by Hodgins as seedlings in his nursery at Dunganstown, Wicklow. Here *Ilex Perado* was cultivated; and old specimens producing flowers and fruit freely are still common in Wicklow gardens. The holly hybrids are vigorous trees, bearing large leaves intermediate between the parent species. The sports of the common holly are always grafted, and are feeble in growth, with a tendency for single branches to revert occasionally to the normal form.

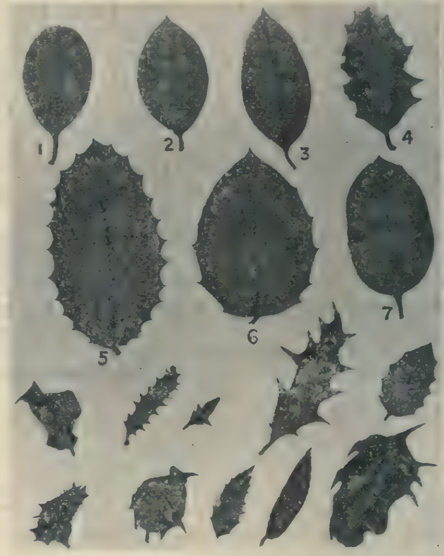

FIG. 2.—Holly. Species:—1. *Ilex Perado*; 2. *I. Balearica*; 3, 4. *I. Aquifolium* (native). Hybrids:—5. *I. Wilsoni*; 6. *I. Hodginsi*; 7. *I. Hendersoni*. Sports:—The leaves not numbered are those of different sports of the native holly.

With regard to hybrids, Prof. Henry, by historical research and experiment, has established the fact that many fast-growing trees in cultivation as the Lucombe Oak, Common Lime, Cricket Bat Willow, Black Italian Poplar, etc., are hybrids. By artificial pollination (Fig. 3) he has succeeded in raising new hybrids, which display the extraordinary vigour characteristic of the first generation cross; and in his paper gives an account of these. The most notable so far are a new hybrid Poplar (*Populus generosa*) and crosses between the Common Ash and American species of Fraxinus.

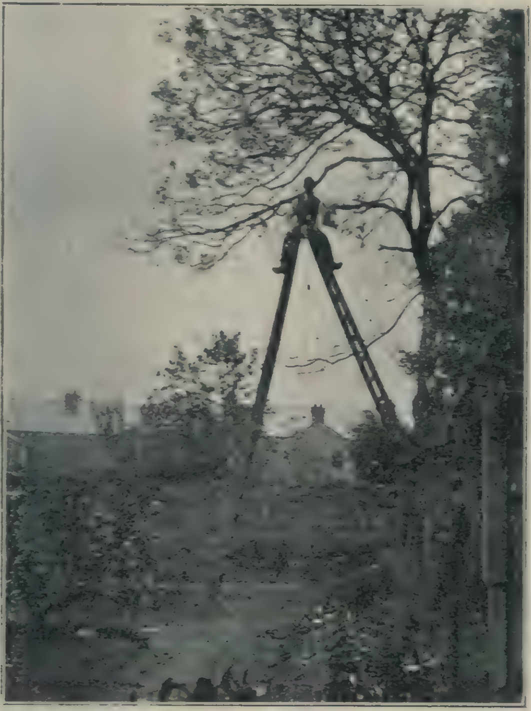

Fig. 3.—Cross-fertilising a walnut tree. The bags are on the branches above and to the left of the operator.

OPTICAL GLASS AND SCIENTIFIC INSTRUMENTS: UNITED KINGDOM IMPORTS AND GERMAN EXPORTS.

In reply to a request for information upon the subject of imports of optical glass and scientific instruments from Germany and elsewhere, the Commercial Intelligence Branch of the Board of Trade has favoured us with a statement showing the imports of scientific instruments and apparatus and parts into the United Kingdom in 1913, distinguishing principal countries whence consigned. We have received, in addition, a statement of the German exports of optical glass and glass instruments in 1912, distinguishing, *inter alia,* the exports to the United Kingdom, as well as particulars of the exports from Germany to the United Kingdom in 1912 of other scientific instruments. As these particulars are of interest and importance at the present time, in connection with efforts being made to provide for increased supplies of optical and chemical glass and scientific instruments from manufacturers in the United Kingdom, they are here reprinted by permission of the Board of Trade.

Imports of Scientific Instruments and Apparatus and Parts into the United Kingdom in 1913. Extracted from the "Annual Statement of Trade of the United Kingdom."

Scientific Instruments and Apparatus (other than Electrical) Complete.

	£
Total imports	710,341
Of which from Germany ...	362,891
Belgium ...	28,939
France ...	108,040
Switzerland ...	19,872
U.S.A.	182,293

Parts thereof (including Kinematograph Films, Photographic Plates, and Films and Sensitised Photographic Paper).

	£
Total imports	2,373,426
Of which from Germany ...	310,229
Belgium ...	126,725
France ...	522,682
Switzerland ...	28,762
Italy	121,842
U.S.A.	1,256,311

Exports of Scientific Instruments (other than Glass) from Germany to the United Kingdom in 1912. Extracted from the Official German Trade Returns.

	100 kilogs	Marks
Optical measuring instruments (polariscopes, etc.) nautical compasses, astronomic telescopes, and other astronomic, geodetic, nautical, etc., instruments ...	87	317,000
Pedometers, pocket instruments for recording, etc., automatic measuring and registering apparatus, speed indicators, automatic balances, etc.	1,991	1,222,000
Cases of geometrical instruments, ruling pens, mathematical instruments, etc.	75	167,000
Calculating machines	94	173,000
Surgical instruments	472	766,000
Precision balances, instruments for metrology and gauging barometric, calorimetric, thermometric, and chemical instruments	453	402,000
Physical teaching apparatus ...	75	67,000

100 kilogs. = 220·46 lb. Mark = 11·8*d.*

Exports of Optical Glass and Glass Instruments in 1912, Distinguishing Principal Destinations. Extracted from the Official German Trade Returns.

Terrestrial Telescopes, Opera Glasses of all Kinds.

	100 kilogs	1000 marks
Total exports	1618	7104
Of which to France	78	372
United Kingdom ...	132	695
Italy	140	534
Austria	191	1034
Russia	390	1686
Switzerland ...	67	494
Turkey	55	212
United States ...	102	273

Other Optical Glass, Ground and Mounted (Telescope Objectives); Stereoscopes, Microscopes, Unmounted Lenses for Optical Work.

	100 kilogs	1000 marks
Total Exports	1764	4659
Of which to France	92	265
United Kingdom...	202	638
Italy	61	174
Netherlands ...	76	183
Austria	130	377
Russia	209	609
Switzerland ...	137	334
Japan	239	436
United States ...	244	482

Photographic Lenses, Ground and Mounted, Photographic Objectives and Apparatus of all Kinds, Unmounted Lenses for Photographic Work.

	100 kilogs	1000 marks
Total Exports	3053	7503
Of which to Belgium	121	322
France	259	786
United Kingdom...	462	1323
Italy	202	606
Netherlands ...	110	199
Austria	412	1036
Russia	564	1092
Switzerland ...	180	514

Glass Thermometers, Combined or not with other Materials.

	100 kilogs	1000 marks
Total Exports	3195	2477
Of which to Belgium	139	92
France	282	265
United Kingdom...	195	132
Austria	352	268
Russia	484	367
Sweden	104	81
Switzerland ...	178	151
Argentina	160	35
United States ...	460	233

Apparatus and Instruments of Glass (including Glass Tubes) Combined or not with other Materials.

	100 kilogs	1000 marks
Total Exports	13699	5865
Of which to Belgium	666	194
France	701	288
United Kingdom...	2384	812
Italy	805	346
Austria	1126	535
Russia	1091	967
Switzerland ...	856	329
United States ...	3021	1009

100 kilogs. = 220·46 lb. Mark = 11·8*d*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—Arrangements are to be made for special intermediate examinations for refugee students, internal and external.

A new syllabus has been approved for hygiene at the M.B., B.S. examination.

The Paul Philip Reitlinger prize has been awarded to Alfred Hope Gosse, London Hospital Medical College, for an essay on the heart in acute rheumatism.

The Sir John William Lubbock Memorial prize for mathematics has been awarded to Ruth Wilks, Bedford College, on the result of the B.A. and B.Sc. honours examination.

Two courses of free lectures in scientific subjects for advanced students of the University and other persons interested are announced in the issue of the *London University Gazette* for December 30, 1914. A course of nine lectures with practical work in dynamical meteorology will be held at the Meteorological Office, South Kensington, by Dr. W. N. Shaw, on Fridays from 3 p.m. to 5 p.m., beginning on January 22. A course of fourteen lectures on development and life-cycles in the Protozoa will be given at the Lister Institute of Preventive Medicine by Prof. E. A. Minchin, at 5 p.m. on Tuesdays and Fridays during the second term, beginning on January 26. Each lecture will, when possible, be followed by exhibits of microscopic preparations illustrative of the subject of the lecture.

AT the Sir John Cass Technical Institute, Aldgate, E.C., on Wednesday, January 13, Sir Robert G. C. Mowbray, Bart., prime warden of the Worshipful Company of Goldsmiths, will distribute the prizes and certificates and open the new metallurgy laboratory for the mechanical testing of metals and alloys, presented to the institute by the company.

IT appears from the new issue of "The Classified Directory to the Metropolitan Charities" that the approximate income for 1913–14 of the various groups of benevolent institutions with headquarters in or near London was 8,705,980*l*., an increase of 617,202*l*. on the previous year, notwithstanding that upwards of four millions and a quarter had been given to the National Relief Fund, and great sums were raised for other purposes to ameliorate the conditions arising out of the war. The institutions receiving this help include hospitals, religious organisations, charities for the afflicted, and so on, and among them we notice educational institutions which together received 625,289*l*. The educational institutions which have received such aid include training colleges for teachers, public schools for boys and girls, and colleges where scholarships and exhibitions endowed by City companies and other corporations are held.

THE report to the Clothworkers' Company of the advisory committee on the work during 1913–14 of the departments of textile industries, tinctorial chemistry, and dyeing and art in the University of Leeds has been circulated. The department of textile industries is now under the direction of Prof. A. F. Barker, who had under his supervision during the session 154 students, 53 of whom were day students. The report points out that the South African Government is undertaking most exhaustive experiments on the effects of various sheep dips on the wool during the subsequent processes of combing, spinning, weaving, and finishing. Half the specially treated wool is being manufactured in the department, duplicate lots being treated at the Bradford Technical College. Most useful results from this interesting work are anticipated. The department of tinctorial chemistry has continued to take a prominent part in the movement directed by the Textile Institute to bring about legislation dealing with falsification of "indigo dyed" woollen materials, and Prof. Green, the head of the department, was a member of a deputation from this body which was invited by the Board of Trade to lay the case before them. The work conducted has already had a marked influence on the quality of the dye used for "indigo" cloths.

THE first number of the fiftieth volume of the Bulletin of the Massachusetts Institute of Technology, Boston, that for December, 1914, takes the form of a catalogue of the officers and students of the institution, with a statement of the requirements for admission and a description of the courses of instruction. Regular four year courses of study leading to a degree are offered in fifteen branches of science and engineering. In most of these courses distinct options are offered in the later years which enable the student to concentrate more of his attention upon some one side of his profession. In no case, however, is the specialisation carried so far as to preclude a thorough training in all the fundamental branches of the subject. The courses in applied chemistry, metallurgy, electro-chemistry, and sanitary and industrial biology serve to prepare students as scientific experts and for professional positions in manufacturing establishments and Government laboratories. Thorough courses in pure science, namely, in chemistry, physics, biology, geology, and general science, are also arranged.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, December 17, 1914.—Prof. E. B. Poulton, president, in the chair.—M. **Christy**: A remarkable gall believed to be new in this country. The gall is in the nature of a "witches'-broom," but appears on *Salix fragilis*; whereas no "broom" of the kind has hitherto been recorded on any species of willow in this country. It appears in great abundance on all trees of the species named growing in proximity. According to Prof. Nalepa, it is due to a gall-mite *Eriophyes triradiatus*, but not improbably a parasitic fungus may assist. So far, the gall is confined, apparently, to a limited area within a radius of, say, twelve or fifteen miles around London. The gall is remarkable in that it appears on the female flower, which develops during summer, until it resembles a bunch of moss, of an olivaceous green colour, from 2 to 8 in. in length, hanging from a small twig. The bunch consists of hundreds, perhaps thousands, of abnormal flowerets.—W. M. **Webb**: The Brent Valley Bird Sanctuary. Twelve years ago the Brent Valley Branch of the Selborne Society took steps to protect a wood of nineteen acres in its district, not far from Ealing, which had long been known as an abiding place for birds. The immediate object was to preserve the nightingales; and a small committee was formed to approach the tenant of the farm on which the wood was situated with a view to the appointment of a watcher. Ultimately, the committee appointed its own keeper, took over the wood from the farmer, and now rents it direct from the owners. No very rare birds occur in the wood, but it is important in the neighbourhood of large towns to give an opportunity to the commoner kinds of nesting undisturbed. Forty-one species have been recorded as breeding in the wood, thirty-nine of them during recent years. Among these may be mentioned the nightingale, lesser whitethroat, the blackcap, garden-warbler, chiffchaff, willow-warbler, long-tailed tit, marsh-tit, tree-creeper, hawfinch, goldfinch, redpoll, nuthatch, wryneck, cuckoo, red-backed shrike, turtle-dove, and wild duck. Including the winter migrants and occasional visitors, eighty-eight species have been observed in or close to the wood. Of these, the golden-crested wren, all the three British woodpeckers, the nightjar, the brown owl, the barn owl, the snipe, and the kingfisher are seen commonly or from time to time. Owing to the introduction of nesting-boxes, several species have increased in numbers or have been induced to nest.

DUBLIN.

Royal Dublin Society, December 15, 1914.—Prof. W. Brown in the chair.—J. **Doyle**: The change of the petiole into a stem by means of grafting. A sprout was grafted on a petiole of *Pelargonium zonale*, v. *meteor*, all the other buds and leaves being removed. After a short time the petioles carried large plants, completely functioning as stems, while the qualities of a stem, viz., indefinitely active cambium, the appearance of interfascicular cambium, considerable secondary thickening, periderm formation, were all taken on by the petiole. The possible causes of this secondary thickening are to be sought (1) in the removal of correlational influences; (2) in increased mechanical strain; (3) in some influence exerted as a result of foliar development. This influence is probably bound up with the water economy of the plant—particularly transpiration—but its precise nature has still to be determined.—Prof. J. B. **Butler** and J. M. **Sheridan**: A preliminary account of a new œdanometer for measuring the expansive force of single seeds or similar bodies when wetted. The apparatus described consists of two strong iron castings bolted together, and holding between them a diaphragm of sheet rubber. The seed to be tested is dropped through a cylindrical passage in the lower casting on to the rubber diaphragm. It is then packed round with fine sand, and covered by a disc of wire gauze. A strong plunger is screwed firmly home on the seed and sand, packing it tightly. Water can be admitted through holes drilled in the plunger. A hemispherical space directly over the rubber diaphragm in the upper casting contains mercury, which is in communication with a fine bore thermometer tube containing air. The upper end of this tube is closed. When water is admitted to the seed it swells; the swelling force is transmitted through the rubber diaphragm to the mercury, and thence to the air in the thermometer tube, compressing it. In this way the pressure, developed by one or more large seeds, can be measured. From single broad-bean seeds pressures of from 28 to 30 atmospheres were obtained. Six peas placed in the apparatus registered from 45 to 50 atmospheres.—Prof. J. **Wilson**: An example of the multiple coupling of Mendelian factors. The English varieties of the campine breed of fowl are described from the Belgian varieties, but are now slightly different in type as regards plumage. The matings by which the Rev. E. Lewis Jones and others produced the English type show that four factors are coupled. If M = the male factor, F = female; E = English type, b = Belgian; Bl. = black colour, g = gold; and Bd. = barred plumage, and p = plain, the factorial representation of a Belgian type "silver" campine hen is

$$\begin{array}{c}\mathrm{M}\\ \mathrm{b}\\ \mathrm{Bl}\\ \mathrm{Bd}\end{array}\boxed{\begin{array}{c}\mathrm{F}\\ \mathrm{E}\\ \mathrm{g}\\ \mathrm{p}\end{array}}$$

The four factors placed in the closed bracket are coupled.—Prof. H. H. **Dixon** and Miss E. S. **Marshall**: A quantitative examination of the elements of the wood of trees in relation to the supposed function of the cells in the ascent of sap. Measurements of the cross-sections of the various elements of the wood of various trees were made by weighing the parts of cut-out photomicrographs of the wood. In this way the percentage of the total cross-section occupied by vessels, tracheids, cells, and walls was determined. The assumption that the transpiration current is raised by the protoplasmic streaming in the cells is shown to be untenable owing to the velocity of streaming it would require.—Prof. H. H. **Dixon** and W. R. G. **Atkins**: Osmotic pressures in plants. Part iv.—The constituents and concentration of sap in the conducting tracts, and on the circulation of carbohydrates in plants. Throughout the year appreciable quantities of carbohydrates are present in the transpiration stream of trees. Their concentration is always greater than that of the electrolytes. In deciduous trees the concentration of the carbohydrates attains a maximum in spring, and is at its minimum in summer. In evergreens there are two cusps in the concentration curve. The distribution of carbohydrates is a function of transpiration no less important than the conveyance of nutritive salts. The coating of wood parenchyma round the vessels is to be regarded as a glandular sheath for the secretion of carbohydrates into the transpiration stream. The medullary rays store these materials and convey them to the sheaths.

Paris.

Academy of Sciences, December 28, 1914.—M. P. Appell in the chair.—Paul **Appell**: The principle of the minimum of the energy of accelerations and the substitution of force linkages.—Ph. A. **Guye** and F. E. E. **Germann**: The influence of the gaseous impurities of silver on the values of the atomic weights determined by the classical methods; the atomic weights of chlorine and of phosphorus. Referring to their recent determinations of the amounts of carbon monoxide and water in highly purified silver found after fusion in hydrogen, it is shown that the use of such silver in atomic weight determinations would lead to a value about 0·005 too high, a negligible quantity. The effect of such an error on other atomic weights based on silver is discussed. The resulting corrections are of the order of 1 to 2 units in the second decimal place, exceptionally 3 to 4 units. Phosphorus, for example, would be lowered from 31·028 to 31·007.—F. **Gonnessiat**: The eclipse of the sun: results.—A. **Buhl**: The intervention of the formulæ of Riemann, Stokes, and Green in the extensions of Abel's theorem.—Lucien **Godeaux**: Triple surfaces endowed with a finite number of points of diramation.—R. **Marcille**: Determination of the Hübl iodine number in alcoholic liquids. The iodine numbers of essential oils. The determinations must be made in liquids containing a definite alcohol concentration, and the reaction must be carried out in the dark.—Henry **Hubert**: The diabase veins of western French Africa.—D. **Eginitis**: The recent earthquakes at Thebes. The village of Thebes was ruined by an earthquake on November 17, 1914, this being the fourth time this has happened within the last sixty-two years. The seismographs at Athens due to this earthquake are discussed. The three violent shocks of the first day have been followed by a series of smaller ones. Up to the middle of December more than 500 shocks coming from the same epicentre have been recorded at the Athens Observatory. This long duration is one of the characteristics of earthquakes in this part of Greece.—E. M. **Martel**: The Mammoth Cave, Kentucky. Diagrams of four transversal sections are shown, showing the arrangement of the three principal stages.—L. G. **Seurat**: The morphology of the female genital apparatus of the Spiruridæ.

BOOKS RECEIVED.

Home University Library. Nerves. By Dr. D. F. Harris. Pp. 256. (London: Williams and Norgate.) 1*s.*

Atlas of Japanese Vegetation, with Explanatory Text. Edited by Prof. M. Miyoshi. Set xv. 102–7. (Tokyo: Maruzen Co., Ltd.; London: W. Wesley and Son.)

Scientific Method in Philosophy. By Hon. B. Russell. (Herbert Spencer Lecture.) Pp. 30. (Oxford: Clarendon Press.) 1*s.* 6*d.* net.

Flora of Jamaica. Vol. iii. Dicotyledons. Families Peperaceæ to Connaraceæ. By Drs. W. Fawcett and A. B. Rendle. Pp. xxiv+280+5 plates. (London: British Museum (Natural History); Longmans and Co.) 15*s.*

All about Leaves. By the late F. G. Heath. Pp. ix+228. (London: Williams and Norgate.) 4*s.* 6*d.* net.

A Course of Pure Mathematics. By G. H. Hardy. Second edition. Pp. xii+443. (Cambridge University Press.) 12*s.* net.

Commission Electrotechnique Internationale. Fasc. 27. Symboles Internationaux. Pp. 15. (London: Waterlow and Sons, Ltd.) 2*s.*

Animal Experimentation and Medical Progress. By Prof. W. W. Keen. Pp. xxvi+312. (Boston and New York: Houghton, Mifflin and Co.) 7*s.* 6*d.* net.

DIARY OF SOCIETIES.

FRIDAY, January 8.

Royal Astronomical Society, at 5.—Total Eclipse of the Sun, 1914, August 21: Preliminary Account of Observations at Minsk, Russia: H. S. Jones and C. R. Davidson.—Preliminary Report on the Total Eclipse of 1914, August 21, Observed at Hernösand, Sweden: Rev. A. L. Cortie.—Total Solar Eclipse, 1914, August 21: Report on an Expedition from the Solar Physics Observatory, Cambridge, to Theodosia, Russia: H. F. Newall.—Total Solar Eclipse of 1914, August 21: Report on the Kiev Expedition: A. Fowler, E. H. Hills, and W. E. Curtis.—Reply to Prof. Sampson's Objections to the Hypothesis of a Sun-spot Swarm: H. H. Turner.—A New Method of Discovering Periodicities: J. J. Craig.—The Influence of Local Atmospheric Cooling on Astronomical Refraction: Sir J. Larmor.

Geologists' Association, at 8.—The Value of Graptolites to the Stratigraphical Geologist: Gertrude L. Elles.

MONDAY, January 11.

Royal Geographical Society, at 8.30.—The Adai Group of the Caucasus: H. Raeburn.

TUESDAY, January 12.

Institution of Civil Engineers, at 8.—The Lateral Pressure and Resistance of Clay, and the Supporting Power of Clay Foundations: A. L. Bell.

THURSDAY, January 14.

Institution of Electrical Engineers at 8.—The Shape of the Pressure Wave in Electrical Machinery: Dr. S. P. Smith and R. S. H. Boulding.

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THURSDAY, JANUARY 14, 1915.

THE WAR.

THE war drags on; and we are learning to understand the mentality of the German race more completely. It is being revealed in various forms. The policy always adopted by the bully, of attempting to terrorise by attack on defenceless persons, is shown by the shelling of the watering-places of Yorkshire, resulting in the murder (for that is the only word which fits the case) of 103 harmless people. "Murder" should certainly have been the verdict, although it was disallowed by the coroner; for although the commanders of the German vessels may not yet be known by name, a verdict of murder would have rendered them subject, when captured, to trial by a British jury. The cowardly and murderous onslaught has led, we are told, to rejoicings in Berlin. It is as we feared; the German nation has lost its moral perspective. They may rest assured, however, that there will be no similar reprisals on the side of the Allies. We do not revenge ourselves on innocent women and children.

It was scarcely worth while, perhaps, for the French universities and British men of letters and science to have replied to the self-named "intellectuals" of Germany. Neutral countries have already made up their minds from the perusal of official documents, not the least important being those from German sources, that the war is one of pure aggression on the part of the Germans. We hear from Switzerland, from America, and from Scandinavia that the public in these countries now pay no attention to German polemic literature. If they had conceivably had any case, they have given it away by their inhuman acts, which have raised a sentiment of disgust in every civilised mind.

We look with contemptuous amusement at the childish renunciation of foreign honours by our Teutonic colleagues in science. That is even the attitude of some of their own countrymen; Prof. Verworn, of Bonn, writing in the *Berliner Tageblatt*, describes it as unworthy of German men of science, and Profs. Waldeyer, Martin, and Orth have protested against the foolish conduct of their countrymen. We can only shrug our shoulders and say that the loss is theirs, not ours.

We have also been disillusioned by the words of the well-known Celtic scholar, Prof. Kuno Meyer, late of Liverpool University, now of Berlin, who has acted, and is acting, as an agent of the Prussian Government in attempting to excite the feelings of Nationalist Ireland and of American Irish in favour of Germany. Here is a man, eminent in his own subject, speaking English without an accent, who has spent thirty years of his life in an English university, a man who has (or had) many intimate friends in this country and has been received in many English households as a friend, turning out to be a dastardly enemy. Savages have a code that, after breaking bread in a man's house, it is treacherous to war against him; not so Prof. Kuno Meyer. This is evidently another instance of "Kultur." It behoves us to treat with suspicion all naturalised aliens of Teutonic extraction; and yet we know, alas! that in doing this, we are acting unjustly in some cases. But the individual, in these days, must suffer for the crimes of his countrymen. It is such instances as these which make the Allies determined that such a race must be deprived of power to do further mischief, whatever be the cost in life and money.

Some correspondence has appeared in the Press as to the relative merits of German contributions to science, as compared with the achievements of members of other races. The discussion is perhaps a useful one; for there is little doubt that the German estimate of the scientific ability of their own people is a much exaggerated one. The statement made in a previous issue of NATURE (October 8) that German science has not been remarkable for originality appears to meet with general assent. We in England have been always more intent on welcoming a discovery than in inquiring into the nationality of the discoverer; indeed, it is a common saying that science is international. But we are beginning to revise our verdict. Prof. Karl Pearson, Prof. Sayce, and Sir E. Ray Lankester have shown that Germany has played only a small part in inception of scientific truths, although by organisation she has greatly extended their application. Huxley and Bywater held this view, each as regards his own subject; and it appears to be shared by geologists, physicists, and chemists. "Ausarbeiten" is the goal of the Germans; the inventive faculty has not been their strong point. Perhaps a mixed race gains in original ability; both flint and steel are necessary to produce a spark. But one thing the German man of science knows how to do well—to exalt the achievements of his nation, often by ignoring that of others. This has probably been done in many cases without intention; it appears to be one way in which German patriotism manifests itself.

Dr. Hugo Schweizer, an Americanised German, writing in the *Popular Science Monthly* (December issue), maintains the thesis that the development of science owes much, if not all, to the stimulus of the demands of Prussian military requirements. Naturally, his examples refer entirely to technical applications of science. And here, again, if they are analysed, it can be shown that the development of which he boasts is due to concentrated and organised effort; of the starting-points of the manufactures which he cites, few are of German origin. They have been appropriated and worked out, no doubt, in order to place the materials of war at the disposal of the German Army; but it is not proved that the necessities of peace are not more effective as a stimulus to progress than those of war. To take only one instance, it is probable that sooner or later all our railways will be electrified; but that would not suit military exigencies; each train must have an independent motive power; and so long as German militarism persists, we may reckon that German railways, at least, will not be run by the electric current.

The aims of science are the antitheses of those of war. It is the object of pure science to attempt to know and correlate natural phenomena, and its devotees are inspired by an insatiable curiosity; it is the object of applied science to make use of that knowledge for the benefit of mankind. To degrade its applications to the destruction of life and property is the most unscientific act of which a people can be guilty.

LORD AVEBURY: BANKER AND NATURALIST.

Life of Sir John Lubbock, Lord Avebury. By H. G. Hutchinson. Two vols. Vol. i., pp. xiv + 338. Vol. ii., pp. x + 334. (London: Macmillan and Co., Ltd., 1914.) Price 30*s*. net, 2 vols.

SIR John Lubbock was a notable figure in the period of our scientific history which saw the birth and development of evolutionary theory. If the part he played was not as weighty as that of Lyell, of Huxley, and of Hooker, it was even more effective. For he spoke as a man of affairs and with convinced sincerity; and if he was "a great banker amongst scientists" so much the better. Like Spottiswoode, he could show that a scientific mind was capable of business success; both, in fact, were members of the X Club, that mysterious body, impossible of successor, which was said "to govern scientific affairs," and "not to do it badly"; Lubbock was, indeed, its last surviving member.

Biography is an art in which any great measure of success is rare. For it demands that the subject should reveal itself while we remain almost unconscious of the hand of the artist. Mr. Hutchinson is more artless, and rivals Boswell in the feat of giving us himself as well. He could not draw on letters, the biographer's best resource; to Lubbock, he explains, "exposure of the holy sanctities of his being would have been impossible." Apology seems unnecessary, then, for Lubbock's "attending the services at the village church" and reading his Bible, though Huxley did the latter and to some purpose. The explanation is found in the belief "that there was some room, after all, among the atoms for the spirits." After this it is pleasant to know that 40,000 people attended the last race meeting in his father's park at High Elms; amongst them were the Archbishop of Canterbury and the Lord Chancellor, evidently spirits. Picking holes is rather futile. But two statements, at any rate, catch the eye as perplexing. Sir Gabriel Stokes (i., 85) is made to say that the chance of laying the first Atlantic cable was "only $(\frac{19}{20})20 = \cdot 3585$, or about 2 to 1 against it"; obviously this should be $(\frac{19}{20})^{20}$, and one wonders who and what was the "Consul D'État" (ii., 23) whom Lubbock went to see in Paris.

Mr. Hutchinson says reasonably enough that to anyone who did not know Lubbock's "serene, unruffled calm" one might easily conceive him as "an animated hurricane." Even to read the life is like travelling in an express train with but a blurred impression of successive landmarks. Only one of his many personalities needs treatment here, and that requires a little more justice than it has always received.

Lubbock's father was a mathematician of some repute, and treasurer of the Royal Society when the Duke of Sussex was little more than nominal president. His mother notes that at the age of four "His great delight is in insects." He was some four years at Eton, where he was thought "exceedingly inaccurate," but that must be taken in an Etonian sense. "Against the advice of his tutor he read some natural history and geology." At the age of fourteen his father was obliged to make use of him in the bank. "He and I with a worthy old clerk carried on the business." Lubbock thought that "beginning so early gave him an instinct for business," and well it might. At the age of nineteen he made a minute time-table for his day from half-past six to midnight. Science and literature fill the compartments; 9.30 to 10 was devoted to "sermons (if I read them any later they invariably send me to sleep)." Such a discipline would have sterilised most men. But his neighbour Darwin gave him a wider training.

He did much sound and valuable work in entomology, and at the age of twenty-four was elected into the Royal Society. He had already made the acquaintance of many well-known scientific men.

And then in 1860 came the "Origin." Lubbock warmly grasped the principle of evolution. The same year he saw Boucher de Perthes at Abbeville; he satisfied himself as to the human manufacture of its stone implements, and that they were contemporary with the mammoth. In 1865 he published "Prehistoric Times." Darwin wrote, "Though you have necessarily only compiled the materials, your general result is most original." He was then contesting Maidstone and was advised to keep the book back, but thought it "would be scarcely honourable"; it is believed to have increased the majority against him. It is rather remarkable that Mr. Hutchinson thinks his writing wanting in "style." Darwin in this respect, and he was no mean judge, thought the book "perfection." A little later he showed that our bronze implements were not, as supposed, of Roman date, and he established against Ferguson the prehistoric age of Stonehenge and Avebury. He secured what was left of the latter from destruction by the builder.

The "Origin of Civilisation" followed in 1870. Frazer admits that it contributed to his own opinions as to the evolution of religion and society, and that Lubbock had anticipated him as to the relation between magic and religion, and the priority of the former.

In his later life he occupied himself with geology and botany, but always from an evolutionary point of view. The former won him the Prestwich medal. He was a keen observer; when exploring with Huxley and Tyndall the lake-dwellings in the Lake of Geneva, he dived more than once after a supposed stone axe, and he produced consternation amongst Swiss geologists by finding nummulites in a rock mapped as Triassic. His botanical work has been thought to deal too much with the trite and obvious, and perhaps it was so to the instructed. But our scientific knowledge is too much a thing apart from ordinary life, and Lubbock wanted to extend its field; no one could be more competent for the task. His "British Wild Flowers considered in Relation to Insects" would be a revelation to most people. The later "Notes on the Life History of British Flowering Plants" show that mere "collecting" leaves the problem of every species untouched. In his great work on "Seedlings" he availed himself of the help of others; it breaks new ground which still awaits a generalisation.

In literature he has been subject to the same criticism. The answer is the wide-world popularity of his writings; the "Pleasures of Life" "was the first book ever published in the Soudan." "Best Books" are on every bookstall.

Lubbock was an optimist. He enjoyed life and laboured that his fellow-creatures might enjoy it more. To that end, as Lord Buxton tells us, he could suppress "interest and desire" if they conflicted with his purpose. His life has been described by one who knew him well as "one of the most useful that was ever lived." It is a worthy epitaph.

ARBORICULTURE AND FORESTRY.

Trees and Shrubs Hardy in the British Isles. By W. J. Bean. 2 volumes. Vol. i. Pp. xvi+688. Vol. ii. Pp. vi+736. (London: John Murray, 1914.) Price 42*s.* net, two vols.

THE appearance of this book, the work of the Assistant Curator of the Royal Botanic Gardens, Kew, will be welcomed by all who are interested in hardy trees and shrubs, for it is the best and most comprehensive work upon the subject that has appeared since the advent of "Loudon's Encyclopædia of Trees and Shrubs," more than seventy years ago. The need for such a work has long been evident, for Loudon's book is hopelessly out of date, not only by reason of the large number of plants which have been introduced in the intervening years, but also on account of the many changes which modern research have necessitated in nomenclature. Since Loudon wrote his famous book the rich regions of western North America, Chile, China, Japan, and other countries have been ransacked for horticultural treasures, and the scope of the present work places good descriptions of these and other woody plants in an easily available form.

The book is divided into two parts, the first being devoted to chapters on cultural requirements and various special subjects, whilst the latter is given up to descriptive matter. The opening chapter gives an interesting epitome of the history of the introduction of hardy exotic trees and shrubs to the British Isles between the middle of the sixteenth century and the present date, due credit being given to the many nurserymen, collectors, and private individuals who encouraged and made such work possible. Following this are chapters upon propagation, hybridising and selection, nursery work, transplanting, arrangement of shrubberies, staking and other means of support, pruning, care of old trees, evergreen trees and shrubs, climbing shrubs, pendulous trees, fastigiate or erect-branched trees, dwarf trees and shrubs, trees and shrubs with handsome fruits, handsome-barked trees and shrubs, variegated and coloured trees and shrubs, fine-foliaged trees and shrubs, autumnal colour in trees and shrubs, early- and late-flowering trees and shrubs, street planting, hedges, trees and shrubs for wet places, shrubs for dry positions and poor soils, shrubs for shady places, and trees and shrubs for the seaside.

All the necessary general information upon each subject is given in a clear and concise manner, but special details of culture required by individual plants are given later in the descriptive part of the work. The early part of the book will appeal specially to the purely practical man, but the more important part, which commences at page 113 of vol. i., and is continued to the end of the second volume, will be found to be of value to everyone who is interested in hardy ligneous plants, whether from the point of view of the botanist, student, landowner, gardener, or forester. Descriptions are given of all the species of trees and shrubs, so far identified, which are of any importance in the British Isles, with many of the most distinct botanical varieties, and in almost every case the descriptions have been prepared from living plants in the Kew collections. The arrangement of genera and species is, as far as possible, alphabetical, this arrangement only being altered where two species are very closely allied, and the distinguishing features can be more clearly defined when the descriptions run concurrently. An ample index of some forty pages, however, atones for this little digression.

One system of description obtains throughout the work. The name of each genus appears in large capitals with the order to which it belongs in small capitals. Then follows a general description of the genus with distribution and special cultural directions. The principal species are then described, each description being headed by the scientific and common names, and, when necessary, the chief synonyms, together with an indication as to where a good botanical drawing of the plant can be found. The following description gives an idea of the general style of the work:—

> L. TRAGOPHYLLA, *Hemsley*. CHINESE WOODBINE.
> (Bot. Mag., t. 8064.)
>
> A deciduous climbing shrub, with smooth young shoots. Leaves oval, tapering about equally to both ends; 2 to 4½ ins. long, ¾ to 2 ins. wide; slightly glaucous above, glaucous and slightly downy beneath. The uppermost pair of leaves are wholly united by their bases, forming a diamond shape; the next pair lower down are less united, but still clasp the stem; still lower down come short-stalked leaves. Flowers bright yellow, produced in a terminal head of ten to twenty. Corolla-tube 2½ to 3½ ins. long, slenderly cylindrical, smooth outside, downy within; across the two lips the corolla measures 1 in. or more in width. Berries red.
>
> Native of the province of Hupeh, China; discovered by Henry and introduced for Messrs. Veitch by Wilson in 1900. It flowered for the first time at Coombe Wood, in July, 1904. L. Caprifolium is closely related, but differs in its whorled flowers and in the smooth interior of the corolla-tube. L. tragophylla is the largest flowered and most showy of the true honeysuckle (Periclymenum) group. It likes a deep moist loam, and Mr. Wilson recommends for it a semi-shaded position.

It will thus be seen that the descriptions are clear, concise, and ample for all practical purposes. Botanical terms have been avoided whenever possible, but in such a work they could not be excluded, and for the benefit of readers who are unfamiliar with such terms an excellent glossary precedes the commencement of part ii.

Mr. Bean's intimate connection with the Kew collections for upwards of a quarter of a century, coupled with his keen powers of observation and critical knowledge of everything connected with hardy ligneous plants, offer a sufficient guarantee for the thorough trustworthiness of the book, and it should find a place in the library of every lover of trees and shrubs, whilst nurserymen and others would do good work, and indirectly pay a graceful compliment to the author, by adopting it as the national standard of nomenclature.

The publisher has done his share in a manner worthy of the firm, and Mr. E. J. Wallis and Miss E. Goldring are to be complimented upon the photographs and drawings. Both author and publisher are to be congratulated upon the production of a book which is likely to be the standard work upon trees and shrubs for at least half a century.

W. DALLIMORE.

FIRST PRINCIPLES OF MATHEMATICS.

Neue Grundlagen der Logik, Arithmetik und Mengenlehre. By Julius König. Pp. viii + 259. (Leipzig: Veit and Co., 1914.) Price 8 marks.

THIS is an interesting and very readable book which, with a comparatively small amount of new notation, discusses the elements of the theory of sets. The most original section is that on "logical forms"; this is a theory of induction more or less corresponding to Whitehead and Russell's theory of types, and axioms of reducibility. The most controversial chapter is that on Zermelo's axiom, and the principle of selection; here the author is very ingenious, but, we fear, not very convincing. Given a class (a, b, c, . . .) he treats the term "a or b or c or . . .", that is (nearly) in ordinary language, "any arbitrary element of the class" as a definite object. He quite rightly observes that this is not an element of the class; but he goes on to say, "In spite of this 'or,' '*a* or *b* or . . .' is a clear experience of our thinking." Of course it is for certain small finite sets, but if we try to extend it, as the author does, to infinite sets, there seems to be a risk of begging the question at issue in the theory of selections. What we want is to justify, and generalise, so far as we can, such expressions as "*take* an arbitrary point on the given circle," "*take* an arbitrary prime number," and so on.

These two examples are of the same type, but they will serve to show part of the difficulty of the question. When a circle is drawn, few would object to the postulate "It is possible to choose an arbitrary point on the circle," it seems so obvious intuitively. But now consider the set of primes, and suppose them arranged in order of magnitude; the millionth of them is a definite existent prime, but what do I mean by "taking" it? I cannot take it in the same sense as I can take two or three or 101, because it has not, so far as I know, been calculated; so I must consider "taking" it as specifying it by a description, belonging to it and to nothing else. But what is there in the general definition of a class to enable us to take an element of it, in the sense required for the theory of selections? How can I "take," for instance, an arbitrary sound or colour? What sort of set (mathematically) is that of pure musical tones? Can we arrange all periodic sounds ordinally? and so on.

It is rash for an outsider to intrude upon such a thorny topic, but we cannot help surmising that Zermelo's axiom (or an equivalent to it) may be like the axiom of parallels in geometry; not necessarily true, but leading, if assumed, to a large body of valuable conclusions. In geometry we have practically only two alternatives to the parallel axiom; it took a long time to discover them, and the only way to disprove the truth of Zermelo's axiom is to find a case that contradicts it. Meanwhile, a safe course is to imitate Whitehead and Russell, and introduce the axiom as a working hypothesis.

It may be noticed that the author pays a warm tribute to Russell's important contributions to the theory of logic. There can be no doubt that they have done much to advance clear thinking, and avoidance of fallacies.

The work is, unfortunately, not quite complete, as the author died before finishing the last chapter. His portrait is given as a frontispiece.

G. B. M.

EGYPTIAN FOLKLORE.

Amulets, Illustrated by the Egyptian Collection in University College, London. By Prof. W. M. Flinders Petrie. Pp. x + 58 + plates. (London: Constable and Co., Ltd., 1914.) Price 21s. net.

PROF. PETRIE is certainly right in suggesting that the subject of Egyptian amulets is one that appeals to the reader of folklore as well as to the Egyptologist. In amulets we are dealing with magic in a concrete form, and it is a problem of no small fascination to recover the meaning which underlay the origin and use of each. It will be obvious that a wide knowledge of Egyptian religious belief is essential, if we are rightly to understand those amulets of peculiarly Egyptian origin. But where the texts fail us we are necessarily thrown back upon comparison with amulets of other races, particularly those of Central African tribes. It is here that folk-lore finds its opportunity, for it not infrequently supplies a clue to the meaning of an otherwise obscure or doubtful symbol.

In the work before us Prof. Petrie has combined both these converging lines of research in a remarkable degree. His material is mainly drawn from amulets in the University College collection, which, as the result of excavation and purchase carried out for many years, he has made as varied as possible; but he has also supplemented these with reference to examples in other collections. He has consequently been able to describe some two hundred and seventy different kinds of amulets, and his classified list, largely the result of pioneer work, places the study upon a scientific basis. Under each heading the Egyptian name is given when known, its meaning and use are suggested, varieties, periods, and material are noted, and references given to the collections where specimens occur.

In his discussion of general principles, the author is certainly right in dismissing with scant sympathy the "confidence theory" and the "faith theory," for though these undoubtedly explain the actual efficacy of amulets, they are entirely out of place as explanations of origins. By far the greater number of Egyptian amulets are most satisfactorily interpreted on the principles of sympathetic magic, or in Prof. Petrie's own phrase, by the "doctrine of Similars." The whole body of funereal magic, as practised by the ancient Egyptians, partakes of this general character, and it is but natural that amulets, whether worn by the living or the dead, should fall under the same category. It is only when we come to detailed explanation that lines of underlying thought or feeling sometimes remain uncertain and obscure. For in sympathetic magic the most obvious connection is not necessarily that which actually led to the employment of a particular object or substance. To take a single example. Prof. Petrie compares the Egyptian series of animal-claw amulets with a leopard's claw from Central Africa (Leicester Museum), and he explains it as an amulet for protection from wild beasts. This explanation at first sight commends itself as not only reasonable but obvious. Yet when we turn to Burton's "Central Africa" we find that in Central Africa the "mganga" or sorcerer might employ a leopard's claw for curing disease. The spirit or ghost with which the sick man was believed to be possessed could by drumming and dancing be driven out of him into a leopard's claw, and when this was hung to a "devil's tree" the disease-spirit was laid. It is true that the leopard's claw was not essential to the process, for in its place a peculiar bead, a nail, or even a rag could be used as the medium for exorcising the disease. But the fact of its employment for this purpose in Central Africa at least suggests the possibility of some other explanation of its use in ancient Egypt than the fear of attack by wild beasts. In several other cases the possibility also suggests itself that the original reason for the use of an object in primitive magic may not have coincided with its later associations when it had survived as an amulet worn on the person.

We have merely referred to these points as indicating the wide interest attaching to the study of the subject. We cannot conclude without a reference to the excellent photographic plates, as well as to the chapters on the use of amulets, in which not only the student and collector, but also the general reader will find much to interest him. L. W. K.

OUR BOOKSHELF.

Science and Religion. By Seven Men of Science. Pp. 138. (London: W. A. Hammond, 1914.) Price 1*s*. net.

IN a week of November last, a series of seven addresses upon the mutual relations of science and religion were delivered by scientific men of distinction at Browning Hall, Walworth Road, London. The lecturers were Sir Oliver Lodge, Prof. J. A. Fleming, Prof. W. B. Bottomley, Prof. E. Hull, Dr. J. A. Harker, Prof. Sims Woodhead, and Prof. Silvanus P. Thompson; and their remarks are now published in convenient and cheap form in the little volume before us.

It would be easy to discuss at great length many of the statements made in these addresses, but no useful purpose would be served by doing so here. In the opening address Sir Oliver Lodge made the definite announcement that he had conversed with departed friends "as I could converse through a telephone with anyone in this audience now"; but apparently it is not everyone who is capable of receiving this evidence of survival of existence. The only evidence upon which a man of science cares to base a conclusion is that derived from his own observations; but in spiritual matters conviction takes the place of phenomenal knowledge. The poet and the metaphysician feel that certain thoughts are true, and the ideas thus conceived are to them as definite facts as any inferences depending upon the use of the senses. Such feelings do not admit of objective demonstration, and cannot, therefore, be measured by the standards of natural or physical science. They belong to another world, which the describer of phenomena may contemplate, but is usually unqualified to enter.

It is not to be expected, therefore, that these addresses will bear the severe criticism to which observations and theories are subjected in scientific circles, and serious students of philosophy are not likely to be impressed by most of the evidence adduced of intelligent design in Nature. The somewhat shallow treatment of this profound subject is, we suppose, explained by the popular audiences to which the addresses were delivered. The book is interesting as a declaration of men of science to the reality of religious conviction; but it may be doubted whether any particular significance should be attached to their views upon questions outside the domain of objective truth in which alone they can give authoritative testimony.

A Study of the Circular-arc Bow Girder. By Prof. A. H. Gibson and E. G. Ritchie. Pp. viii + 80. (London: Constable and Co., Ltd., 1914.) Price 10*s*. 6*d*. net.

THIS book treats of the difficult problem of girders forming a circular arc in plan such as are often used to support the balcony of a theatre. The principles on which the general problem may be solved are given in the early portion of the volume, and are amplified from a paper read by Prof. Gibson before the Royal Society of Edinburgh in 1912. Values of the end fixing moments and reactions have been calculated for the more important practical cases, and these values, together with typical bending moment diagrams which are given, will be found useful aids to the designer. The authors have carried out experiments with a view of checking the theoretical investigation, and remarkable agreement is shown. Up to the appearance of this volume there has been no data available for the torsional rigidity of beams of ordinary commercial section, and part of the investigation undertaken by the authors has been the experimental determination of the product CJ (*i.e.*, modulus of rigidity × equivalent polar moment of inertia) for such sections. Mathematical calculations in such cases present insuperable difficulties, and the experimental work given in the book is an interesting and valuable contribution to our knowledge of materials. A chapter on the general principles of design of the bow-girder is included, and will be of service to the practical designer, to whom a considerable portion of the volume will be sealed on account of necessarily complicated mathematical treatment. The authors may be congratulated on the success with which they have solved a very difficult practical problem.

Spectrum Analysis, applied to Biology and Medicine. By the late Dr. C. A. Macmunn. Pp. xiv + 112. (London: Longmans, Green and Co., 1914.) Price 5*s.* net.

THE late Dr. Macmunn belonged to a class of which British science does well to be proud: the class of men who, notwithstanding the arduousness of their professional labours, find or make time to engage in research. Born in Ireland and educated at Trinity College, Dublin, Macmunn practised medicine for twenty years at Wolverhampton, and during that period published his researches in the application of spectrum analysis to biology and medicine. The present work, as we learn from the preface by Prof. Gamble, was begun and continued between attacks of severe illness and was left in an unrevised state.

Dr. Macmunn was an early worker in the field and deserves the credit of the pioneer. Although no remarkable discovery attended his efforts, he contributed valuable observations on the nature of the various colouring matters both in animals and in plants. He demonstrated that the pigments of not a few animals contain chlorophyll: a demonstration confirmed in certain cases by the discovery of algæ living symbiotically in the tissues of these animals.

Although the professional man of science who specialises in this department of research may not need to consult this work, we welcome it and hope that it may be widely circulated and read, for it is a worthy record of the labours of one who loved research and ensued it with ardour and success.

The Geographic Society of Chicago, Bulletin No. 4. The Weather and Climate of Chicago. By Prof. H. J. Cox and J. H. Armington. Pp. xxv + 375. (Chicago: University of Chicago Press, 1914.) Price 12*s.* net.

MESSRS. COX AND ARMINGTON have made a statistical study of the climate of Chicago of extraordinary detail. The result is valuable as a book of reference, but cannot be described as easy reading, chiefly owing to one hundred and forty-five tables intercalated in the text. Records of temperature extend back to 1830 and of rainfall to 1843, but the series are not homogeneous, there being several changes even in the shorter period 1871 to 1911, which is adopted for normal values. Normals, however, are not regarded as so important as the occurrences of abnormal conditions and rapid variations which render the climate healthful and invigorating—and with a temperature range from −16° to +103° F. there is abundant room for rapid changes. The extremes would be even greater but for the near neighbourhood of Lake Michigan, as is well shown by a study of the lake breezes, and by temperature records at different distances from the shore. The abnormal periods are further considered, not merely locally, but as part of the weather of the whole States, and this aspect is illustrated by reproductions of the daily synoptic charts, unfortunately sometimes so small as to be almost undecipherable. Full use is made of isopleth diagrams for exhibiting hourly variations; a feature with less to recommend it is the replacement of departures from normal temperature by accumulated departures, which are said to be "more vivid"—though it is not self-evident that an "accumulated" departure of +1262° conveys more to the mind than a mean departure of +3½°.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Experiments on Hay Infusions.

DR. BASTIAN's interesting experiments suggest further considerations, particularly as to the osmotic effects of solutions of different strengths and temperatures. A solution of hay made at a higher temperature will probably be a stronger solution containing more soluble matter, and also more silicate from the glass. A solution kept for a fortnight may evaporate and become more concentrated. Does one concentration produce Zooglœa, and a greater concentration produce spores?

Am I right in thinking that the general effects of increasing concentration are crystallisation, precipitation, an increasingly dense protoplasm, a thickening cell-wall, and cell subdivision? Is free-cell formation another process brought about by increasingly concentrated solutions? Is dilution, and especially dilution with warm water, the necessary osmotic condition for bursting the cell-wall and liberating naked or amœboid forms? Can we explain the phases of an organism in terms of its previous history and present conditions?

Where a change takes place in the population of a pond this may, of course, be due to individual transformations of tadpoles into frogs with rise of temperature, or it may be due to differential rates of increase or death, as when in a dry summer sticklebacks die and frogs survive. It is not quite easy to disentangle the transformation and the survival processes when the organisms are minute.

HUGH RICHARDSON.

Stocksfield-on-Tyne, December 31, 1914.

THE ASCENDING SPIRAL.[1]

MANY years ago the author of this interesting and stimulating book became impressed with the widespread distribution of "spirals" in nature. He has persistently followed the clue in the hope of discovering the significance of this form, which is ever-recurrent, especially in the realm of organisms. Many others have been on the same track, and the author refers to Sir John Leslie, Canon Moseley, Prof. Goodsir (on whose tomb in Edinburgh a logarithmic spiral was graven), and Mr. A. H. Church, whose studies of phyllotaxis are well known. It is a track to be followed. A symbol, which adorns the cover of the book before us, is held by the author to indicate that Chinese philosophy had adopted the logarithmic spiral as a symbol of growth so long ago as the twelfth century, and several investigators are still engaged in the twentieth century in the search for that symbol (which we now call a formula). Nor can we forget that Leonardo da Vinci, whose manuscripts the author has studied, was greatly interested in spiral shells—of both living and extinct types, for he was one of the first to appreciate fossils—and used them in his art. Mr. Cook brings forward evidence that the spirals in natural forms made a deep impression on the early artists; and the development of this idea forms a very interesting part of the book, the parallelism worked out between shells and staircases being especially skilful.

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[1] "The Curves of Life. Being an Account of Spiral Formations and their Application to Growth in Nature, to Science and to Art; with Special Reference to the Manuscripts of Leonardo da Vinci." By T. A. Cook. Pp. xxx + 479. (London: Constable and Co., Ltd., 1914.) Price 12*s.* 6*d.* net.

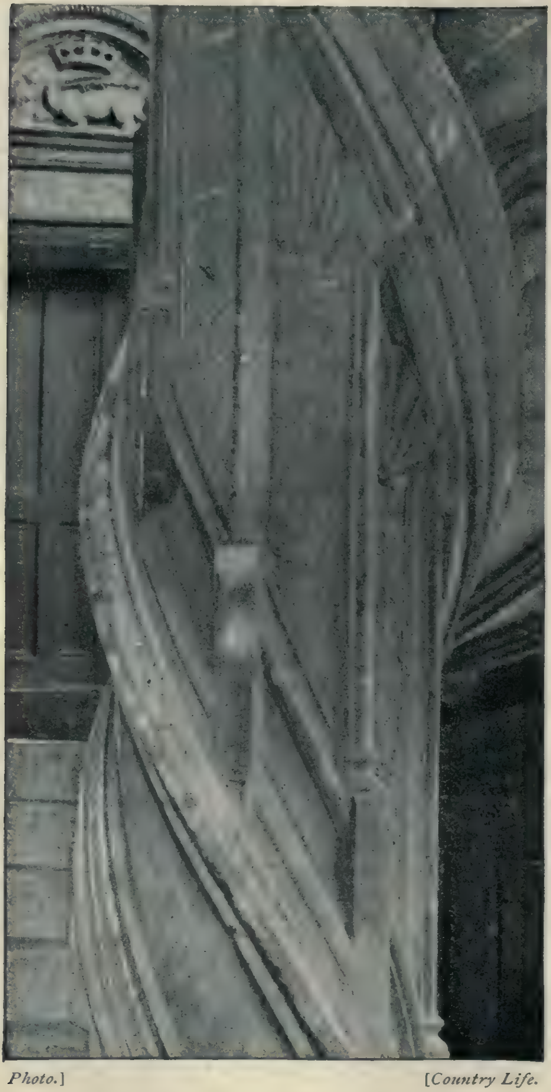

Photo.] [Country Life.

FIG. 1.—Central shaft of spiral staircase in the wing of Francois I., Château of Blois. From "The Curves of Life."

Spirals are sometimes seen in the inorganic domain—in whirling dust, in waterspouts, in starry nebulæ, and in certain crystals. But it is in the organic realm that they abound, and Mr. Cook's record of them is impressive. In Foraminifer and Nautilus, Venus Flower Basket and the horns of an antelope, the typical spermatozoon and the egg-capsule of the Port Jackson shark, the umbilical cord and the cochlea of the ear, the arms of a Lamp-shell and the trachea of an insect, the fir-cone and the Turbine shell, the antherozooid of a Cycad and the stem of the honeysuckle, the spiral vessel of a melon and the twisted fibrils of the muscle-fibres of some molluscs, the fruit-stalk of Cyclamen and the inflorescence of Forget-me-not, the leaves on the stems which find in a Fibonacci series the minimum superposition and the maximum exposure, the seaweed Vidalia like a curled shaving and the still more beautiful staircase of the rare *Riella helicophylla* from Algiers, the twisting tendrils of the vine and the horns of a ram, the double spiral of osseous lamellæ in the shaft of long bones and the staircase within the skate's intestine, a Spirochæte and the muscle-fibres of an arteriole! Sometimes their utility is plain, *e.g.*, in assisting in the distribution of seeds and sperms; or in acting like a spring, as in tendrils and tracheæ; or in allowing many structures to be crowded in a small space, as in buds; or in giving architectural strength as in the lamellæ of bones. Mr. Cook points out shrewdly that there is very often a suggestion of growth under resistance, which might be illustrated by the young leaves in a bud, or the spiral fibre of insect tracheæ, or the Venus Flower Basket building itself up on the floor of the Deep Sea; and we like Mr. Schooling's suggestion that the ϕ proportion is an expression of economy of form.

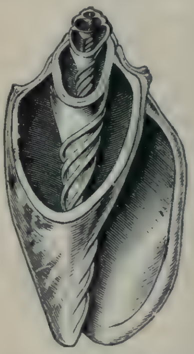

FIG. 2.—The common form of *Voluta vespertilis* (section). From "The Curves of Life."

There is no doubt that Goodsir had a definite expectation that some physiological law of growth or "production" might be discovered by a further study of the recurrent spiral form. We are indebted to Mr. Cook for re-directing attention to this quest.

There are, of course, numberless logarithmic spirals, and Mr. Cook, with assistance from Mr. Mark Barr and Mr. William Schooling, has determined that the form which is most descriptive of those in organic nature is one which he calls the ϕ spiral—one in which the ratio of increase (ϕ) is $(1 \pm \sqrt{5}) \div 2$, or 1·618034, the sum of any two terms being equal to the next term. This kind of spiral is illustrated approximately by many very successful forms of organic growth. We must emphasise the word approximately, for if the ϕ ratio be that of "perfect growth," it is one towards which vital architecture *tends* rather than one which it reaches. Even the Nautilus shell is only an approximation to it, and this to Mr. Cook is half the charm. For the approximateness reveals the *endeavour,* which arouses our sympathy, while mathematical exactness leaves us dull. Life is like an artist, full of individual variability. "Perfect beauty, like natural growth, implies irregular and subtle variations."

But the ϕ proportion is not only a descriptive formula for natural growth, it shows itself in statues and in the proportions of pictures. It looks as if the secret of one type of successful growth (of course, there are other non-spiral architectural creations) echoed in the artist's expression of the beautiful, and even in our appreciation of it. Perhaps the logarithmic spiral with the Pheidias ratio is an "objective" element in beauty, not merely in the sense that mankind was literally brought up on spirals—in days when spiral phyllotaxis was a problem by no means academic, when the coils of the succulent bulb and the toothsome whelk had an interest much more than æsthetic, when the spiral conch called the tribe to war—and when, for we need not expatiate, the spiral mode of growth became the Swastika symbol of good growth and good luck. We should be inclined to press the point that spiral architecture became prevalent in the evolution of organisms because it was, for certain conditions, particularly fit. It was a successful architectural style, discovered among the unicellulars, and always kept, with the sublime conservatism of vital evolution, *available,* for whatever experiment in internal structure or external form might be demanded or prompted by the exigencies of the situation. The secret was much too good to lose. But Man is conservative as well as Nature, and he began to accumulate pleasant feelings in association with all manner of spirals. But Mr. Cook will not be content with any position of this sort. "If ϕ in some way describes the principle of growth, which is one revelation of the spirit of Nature, would not the artist most in touch with Nature tend to employ that proportion in his work, even though he was not conscious of its exisence?" We confess to wishing to work for a while longer with the hypothesis that the artist uses the ratio of Pheidias because it figures largely in Nature, and thus in Man's upbringing. But Mr. Cook's view is subtler, that Leonardo and the Nautilus exhibited a dominance of the ϕ spiral in their respective masterpieces because they were both artists. We like the spiral shell, and still more the spiral staircase of Blois, not merely because impressionable mankind was brought up on spirals, but because the spiral in question represents one of the inmost experiences of life itself—an endeavour after perfect growth. This seems to be Mr. Cook's view, but we are sceptical.

Mr. Cook has given us a delightful study, eloquent of patience in collecting examples of spirals, of delight in measuring them by the Pheidias rule, and of quiet meditation over "the unspent beauty of surprise" and the worldwide treasures of significant form. The personal note is strong and it is pleasant, but we have sometimes wished, as we read the book, that the author had been more methodical, and less swift to move from one problem to another. For there are many problems. (1) There is the question, which Mr. Cook has in part answered, as to the various architectural types—spiral and otherwise—exhibited by organisms—a question to which Haeckel paid considerable attention long ago in his discussion of "promorphology." (2) There is the question of the varied utility of the spiral, which gives it its survival-value. To answering this Mr. Cook has made some contribution. (3) There is the difficult problem of the forces at work in the genesis of the spiral form, of the physical forces or the properties of matter that determine shape. A preliminary (as it were, aeroplane) survey of this borderland between morphology and physics will be found in Prof. D'Arcy Thompson's brilliant presidential address to Section D of the British Association in 1911; and a paper by the same naturalist on the shapes of eggs (NATURE, vol. lxxviii., pp. 111, 158) is also important. (4) There is the question of the recurrence of the logarithmic spiral in human works of art. Nor should we forget the spider's spiral, the making of which is to be ranked beside building nests and shaping honeycomb, not beside the secretion and moulding of shells. (5) Then there is the problem of why these spirals please us, and are joys for ever. In regard to which it should be carefully noted that there are (*a*) physiological, (*b*) intellectual, and (*c*) imaginative or sympathetic factors in our appreciation of beauty. (*a*) There are shapes that sing, and produce pleasant eurhythmic echoes in our bodies. (*b*) There are shapes which arouse happy associations, and others of which the adaptiveness never fails to please. (*c*) There are others, again, which strike a deeper note, in which we recognise a triumph of life over its materials and difficulties. It is in the contemplation of these achievements that the artist in us is thrilled most deeply, sharing a vicarious triumph.

ICEBERG OBSERVATIONS.[1]

AFTER the loss of the *Titanic* in April, 1912, had directed attention to the dangers from ice in the North Atlantic, the Government and the shipowners concerned chartered the *Scotia* as an experimental ice-observation vessel to cruise to the north of the trade routes. The *Scotia,* fitted with wireless and carrying three investigators and two Marconi operators, was commanded by Captain T. Robertson, her former captain in Bruce's Antarctic expedition. Her work was carried on from March to August, 1913, and proved so useful that the year following she was replaced by a specially-built ice-patrol boat of larger size, and so perhaps more suitable for the work, though it would be difficult to construct a stronger, handier, and better ice-boat than the *Scotia*.

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[1] "Ice Observation, Meteorology and Oceanography in the North Atlantic Ocean." Report of the work carried out by the s.s. *Scotia,* 1913. Text, pp. 142. Price 4*s.* 6*d.* Map and Charts. Price 2*s.* 6*d.* (H.M.S.O., 1914.)

The most generally interesting parts of the detailed reports in this volume are those relating to the detection of icebergs by temperature observations. A Callendar self-recording electrical resistance thermometer held at a depth of 2 ft. below the surface failed to indicate any effect of icebergs on the temperature of the sea. In most cases the passage of the *Scotia* by an iceberg did not correspond with any hump or depression in the temperature curve, and when it did it was impossible to distinguish these from the ordinary variations in the temperature of the sea. As this thermometer, which indicated trustworthily variations of 1/10°, was unaffected by passing icebergs it would be useless in practice to employ such a method of detection. In fact, any variation unrecognisable by an ordinary thermometer would be valueless to the seaman. In his investigation on the *Montcalm* Prof. Barnes came to the conclusion that the real effect of an iceberg on the surrounding water is to warm it slightly. Mr. G. I. Taylor found indications of this, but the effect could not be utilised to detect the presence of bergs on the Newfoundland Banks because the temperature of the sea in that region undergoes small rises in places independent of icebergs. Prof. Barnes found his striking indications of these rises of temperature near inshore, but the *Scotia*, on the other hand, was at work hundreds of miles off the land. It cannot have been that the electrical thermometer of the *Scotia* failed to detect these changes, since check temperatures taken in bucket samples with a thermometer reading to 1/20° gave little or no such indication.

Nor did Mr. D. J. Matthews, the oceanographer on board, find any relation between icebergs and sea temperature. He noticed no rise in temperature in the vicinity of ice, but, on the other hand, found sudden changes in many parts of the North Atlantic where there certainly was no ice within 500 miles.

Similar changes in temperature in the sea far removed from icebergs were noted by the patrol of the U.S.SS. *Chester* and *Birmingham* in 1912.

In fact, all that a sudden fall in surface temperature means is that the ship has entered the polar current and may meet ice if there is any in the neighbourhood. A rise in temperature shows that the chances of ice are less, but not that the ship is safe.

Therefore, unless wireless warnings of the extent of the pack and the position of bergs can be satisfactorily circulated, which is doubtful, ships will have to rely on a careful watch from near the water-line, and the development on the part of the look-out or ice-pilot of that extra sense which all polar navigators gain in time that enables them, as they say, to "smell" the presence of ice. The report ends with a lengthy study of the plankton distribution by Mr. L. R. Crawshay, who reached results similar to those of the physical observers on ice-bearing currents.

R. N. R. B.

LIEUT.-COL. D. D. CUNNINGHAM, F.R.S.

WE recorded last week, with much regret, the death on December 31, in his seventy-second year, at his residence, Tormount, Torquay, of Lieut.-Col. D. D. Cunningham, formerly of the Indian Medical Service.

D. D. Cunningham was born at Prestonpans on September 29, 1843, and was the son of the Rev. W. B. Cunningham, one of the most scholarly of the clergymen who left the Church of Scotland at the Disruption of that year. After leaving school young Cunningham entered the University of Edinburgh, where he graduated with honours in the Faculty of Medicine in 1867. Early in 1868 he joined the Indian Medical Service, and at the Army Medical School, Netley, he took a position as distinguished as that which he had attained in his university.

While Cunningham was at Netley the attention of pathologists in this country was directed to the theories regarding the causation of cholera advanced by Hallier and De Bary, and at the instance of the teaching staff of the Army Medical School the Secretaries of State for War and for India resolved to depute the two young officers who should secure the highest places in the Queen's and the Indian Medical services respectively to learn at first hand the nature and bearing of the theories. Cunningham was the young Indian surgeon thus chosen; the officer of the British Medical Service selected was T. R. Lewis, a man of the same academic standing as Cunningham, but a few years his senior in age, who had graduated with honours in medicine, also in 1867, in the sister university of Aberdeen.

As a result of this selection Cunningham spent some time as an inmate of the house of the Rev. M. J. Berkeley, F.R.S., and acquired a knowledge of the technique employed by that distinguished mycologist. In company with Lewis he paid visits to Hallier and to De Bary, proceeding thereafter to Munich to study under the celebrated Pettenkofer, with whom both young men contracted ties of close personal friendship, which subsisted in the case of Lewis until the latter died, and in the case of Cunningham until the close of Pettenkofer's career.

After this period of study in Germany Lewis and Cunningham left for India, where they arrived in 1869. Immediately on landing both officers were attached for special duty to the department of the Sanitary Commissioner with the Government of India, and commenced partly in collaboration, partly independently, the series of pathological studies the excellence of which led to the selection of Lewis for the Fellowship of the Royal Society, at the age of forty-five, in 1886, and to the election of Cunningham to the Society, at about the same age, in 1889. This period of activity continued for eleven years with the happiest results, and the eloquent testimony borne to Lewis's share in their work, in the pages of NATURE for May 27, 1886, on the occasion of the untimely death of that distinguished pathologist, will better enable workers of the present generation to realise and appreciate what the work of Lewis and Cunningham implied thirty years ago.

The collaboration of Cunningham with Lewis came to an end in 1879–80 owing to Cunningham's appointment as professor of physiology in the Medical College of Bengal, and to a modification in the organisation of the Sanitary Commissioner's department. The Sanitary Commissioner was in 1880 made also Surgeon-General with the Government of India, and he was only able to retain the services of Lewis in the capacity of secretary to the Sanitary Commissioner.

The diversion of Cunningham's attention from pathological studies was, however, but of short duration. In 1883 Lewis was offered, and accepted, the post of assistant professor of Pathology at Netley, and Cunningham, who had in the interval established his reputation as a teacher of physiology, was asked to undertake, in addition, the duties of secretary to the Sanitary Commissioner. During the remainder of his Indian career Cunningham fulfilled these secretarial duties on behalf of the Government of India in conjunction with his duties as a professor of physiology on behalf of the Government of Bengal. The conditions under which he had to work differed somewhat from those experienced by his predecessor, whose headquarters, when not on tour, were with the Government of India in their summer capital of Simla, whereas, owing to the exigencies of his college appointment, Cunningham's headquarters were in Calcutta. The work accomplished by Cunningham during the next fourteen years, for which period he was in charge of both posts, was unremitting. This, combined with the fact that his duties involved continued residence in the plains, at length undermined what had been a vigorous constitution, and in 1897 Cunningham's health became so seriously impaired that he had to be invalided to Europe, and a year later found it necessary to retire from the service of the Government. After retirement he settled in Torquay, where, in somewhat indifferent health, he spent the rest of his life.

During the period from 1879 to 1897, spent by him in Calcutta, Cunningham took his share of those unofficial duties that fall to public men. He was a member of council of the Asiatic Society of Bengal and a trustee of the Indian Museum. But the work for which he will longest be remembered in Calcutta was that connected with the Zoological Garden, to the committee of management of which he rendered the greatest service, for many years as their secretary and eventually as their president. Largely owing to his energy and knowledge the institution attained the position which it still holds, whether as regards the wealth of its collection or the health of its inmates. His services to this garden are commemorated by a bronze medallion portrait presented by friends when Cunningham retired from public service.

As a teacher of physiology Cunningham was marked by the philosophical breadth of his thought and by the corresponding width of his outlook. His attention, whether in the class-room or the laboratory, was by no means confined to animal physiology; some of his most suggestive allusions and fruitful studies were botanical. In the pathological field Cunningham was not so much the investigator of morbid processes and diseased states as the student of deviations from normal physiological processes and naturally conditioned tissues. Here again, perhaps to some extent as a consequence of his early association with Berkeley and De Bary, Cunningham was as interested in working out the life-history of pathogenic organisms affecting plant tissues as in studying diseases affecting animals or men.

With capacity for research there went, in the case of Cunningham, great powers of observation, thanks to which we are indebted for the existence of notebooks kept with the utmost care during his thirty years' residence in the East. It was to his friends a source of the keenest satisfaction that although Cunningham after retirement was unable to resume the research work of former years, his health improved sufficiently to admit of his exercising his rare literary gift in presenting some at least of the contents of these notebooks to the world.

Cunningham's work in India was recognised by his being made a Companion of the Indian Empire and, during his residence in the East, an Honorary Surgeon to the Viceroy. After his retirement he became an Honorary Physician to the King.

Possessing a manner of ineffable charm and courtesy, kindly and wise in counsel, Cunningham was endeared to all those who had the privilege of his friendship, and to those of the circle, now sadly diminished, who enjoyed that privilege, his loss is irreparable.

SIR OWEN ROBERTS.

BY the death of Sir Owen Roberts, on January 6, in his eightieth year, the cause of technical education in this country has lost one of its most devoted and influential champions. It is nearly half a century (1866) since Sir Owen was appointed Clerk to the Worshipful Company of Clothworkers. At that time the City Companies had fallen into ill-favour. Their immense revenues, it was alleged, had been diverted from their original purpose of trade protection and advancement, and when the movement for improving technical education was started, shortly after the passing of Mr. Forster's Education Act of 1870, longing eyes were cast upon these revenues. It was then that Sir Owen Roberts, in co-operation with Sir William Sawyer, of the Drapers' Company, and Sir John Watson, of the Mercers' Company, conceived the bold policy which at the same time assisted the cause of technical education and saved the companies from the odium into which they had fallen by providing them with a worthy object for their munificence.

The Clothworkers' Company had already taken a leading part in the foundation of the Yorkshire College of Science (which has since become the

University of Leeds), and it had also made large grants towards the establishment of technical schools at Bradford and Huddersfield; but the first great sign of the City Companies' new activity was the constitution of the City and Guilds of London Institute in 1876. It is impossible to trace here the development of this movement, in which Sir Owen Roberts took a leading part. Suffice it to say that, as a result of it, we now have at South Kensington the magnificent Imperial College of Science and Technology, which owes its existence in no small measure to the munificence of the City Companies.

Sir Owen's position as an educational authority was handsomely recognised when he was appointed one of the seven commissioners under the University of London Act, 1898, entrusted with the duty of reconstituting the University. Sir Owen has since confessed that in his opinion the problem of devising an internal university in London is incapable of a satisfactory solution; but he strove with his fellow-commissioners to do the utmost with the materials at their disposal, and for several years he continued loyally to serve the re-constituted university as a member of its Senate. It is probable that he was more completely satisfied with the work which he did at the Royal Society of Arts. One of the chief aims of that royal and ancient institution has, for the last century and a half, been to encourage industry by the application of science and art—precisely the object which Sir Owen had so much at heart. He was elected a member of the Society's council in 1880, and with the briefest break he continued to serve on it until his death. During nearly all this period he acted as Treasurer, and for one year as Chairman of the Council. He had a great grasp of finance, and to his sound advice is due in large measure the prosperity which the society at present enjoys.

Sir Owen will be missed by a very large circle of public and private friends. His genial personality and warm-hearted friendliness ensured him a welcome wherever he went, and he retained to the end a vigorous vitality that might well have been envied by many a man thirty years his junior.

NOTES.

THE council of the Geological Society has this year made the following awards of medals and funds:—Wollaston medal, Prof. T. W. Edgeworth David, C.M.G., F.R.S.; Murchison medal, Prof. W. W. Watts, F.R.S.; Lyell medal, Prof. E. J. Garwood, F.R.S.; Bigsby medal, Mr. H. H. Hayden; Prestwich medal, Prof. Emile Cartailhac (Toulouse); Wollaston Fund, Mr. C. B. Wedd; Murchison Fund, Mr. D. C. Evans; Lyell Fund, Mr. John Parkinson and Dr. L. Moysey; Barlow-Jameson Fund, Mr. J. G. Hamling.

DR. J. SCOTT KELTIE, secretary of the Royal Geographical Society, has been awarded the Cullum gold medal of the American Geographical Society, in appreciation of his services in the advancement of geographical knowledge. Arrangements are being made by the American Geographical Society, through the United States Department of State, for the presentation to be made to Dr. Keltie by the American Ambassador in London.

THE widow of Prof. Henry Draper, of Harvard, the American pioneer in stellar spectroscopy, died recently in New York. Mrs. Draper was herself one of her husband's most capable assistants in the Harvard College Observatory. On his death in 1882 she presented that institution with his eleven-inch telescope and provided the main funds for the preparation of the great "Draper Catalogue," recording the spectra of more than ten thousand stars, as a memorial to her husband. It is announced in the issue of *Science* for December 25 last that Mrs. Draper has, by her will, left large bequests for public purposes. She bequeaths 30,000*l.* to the Harvard College Observatory for the Draper memorial; her husband's photographic plates and apparatus are also bequeathed to the observatory. The sum of 90,000*l.* is given to the New York Public Library, 40,000*l.* for a memorial to Dr. John S. Billings, and 40,000*l.* as a memorial to her father, Courtland Palmer. The income of these funds is to be used for the purchase of books, and an additional trust fund of 10,000*l.* is given for the benefit of the employees of the library. There is also a bequest of 5000*l.* to the Smithsonian Institution, and of 5000*l.* to the laboratory of surgical research of New York University, of the medical department of which Dr. Henry Draper was at one time dean.

SOME indication of the cause of the severe floods which have of late been so prevalent in the Thames Valley and in other parts of the country can be gathered from the summary of rainfall issued in the Weekly Weather Reports of the Meteorological Office. In the five weeks ending January 2 the aggregate rainfall was largely in excess of the average in all parts of the United Kingdom. The greatest excess of rain occurred in the south-east of England, where the fall was 318 per cent. of the average. The next highest percentage is 284, in the east of England, followed by 246 in the midland counties. In the Channel Islands the rainfall was 223 per cent. of the average, and in the south-west of England it was 200 per cent. In all other districts the rainfall was less than double the normal, and in the west of Scotland it was only 131 per cent. of the average.

A SUMMARY of the weather issued by the Meteorological Office for the fifty-two weeks ended January 2 shows the aggregate conditions for 1914. The mean temperature for the year was in excess of the average in all parts of the British Isles. In the east and north-east of England and in the midland counties the mean temperature was 2° above the average, whilst in all other districts except the north and south of Ireland and the Channel Islands the excess amounted to 1°. The south-east of England was the only district with an absolute temperature of 90°, but the thermometer exceeded 80° in all other districts. The lowest temperature was 7° in the east of Scotland. The rainfall for the year was largest in the north of

Scotland, where the amount was 49·31 in., and it was least in the north-east of England with 24·82 in. The only districts with an appreciable deficiency of rain were the west and north of Scotland, where the percentage of the average rainfall was respectively 91 and 94. In the south-east of England the aggregate rainfall was 125 per cent. of the average, which is the highest difference from the normal, in the Channel Islands it was 121 per cent. of the average, in the south-west of England 119, in the south of Ireland, 111, in the midland counties 109, and in the east of England 108 per cent. In no other district was the rainfall more than 104 per cent. of the average. The rainy days were not generally very different from the normal. There was a slight excess of sunshine in the eastern districts, whilst the western districts were mostly in agreement with the average.

A FEW weeks ago we announced with regret the death in Cambridge, on December 9, of Prof. A. van Gehuchten, professor of the anatomy, pathology, and treatment of diseases of the nervous system in the University of Louvain. Sir Clifford Allbutt, in two short communications to the Educational Supplement of the *Times* (January 5) and the *British Medical Journal* (December 26) expressed the grief of many friends at Cambridge, as well as of biologists generally, at the loss which science has sustained by Prof. van Gehuchten's death. To these sources, and an appreciative obituary notice contributed by Dr. F. E. Batten to the latter journal, we are indebted for the following details. In 1887, after a brilliant career as a student under the late Prof. J. B. Carnoy, and in laboratories at Berlin and Frankfurt, van Gehuchten returned, at the age of twenty-six, to Louvain, where he had been appointed instructor in anatomy, especially in the field of neurology, of which subject he became one of the most original investigators and exponents of our time. During twenty-four years the records of his now famous researches into the nervous system appeared in a series of papers in which each challenged the others in interest and importance. His researches dealt especially with the unit of modern neurology—the neuron; with the origin and causes of the motor nerves; the pathology of certain virulent nervous maladies; the phenomena of normal and morbid reflexes; and incidentally but very effectively with the development of methods. It was in 1897 that he began his long and fruitful series of study on methylene-blue staining methods, a report on which he presented to the International Congress of Medicine at Moscow in that year.

A REMARKABLE human skeleton, discovered by Dr. Hans Reck in the Oldoway ravine in German East Africa, is described in the *Antiquary* for January, by Mr. J. Reid Moir. In the layer resting immediately upon the basal basaltic lava, rhinoceros bones were discovered, and in the overlying deposit, that in which the human remains were found, a great number of elephant bones, differing from the present-day African elephant, and a splendid hippopotamus skull were unearthed. Dr. Reck believes that it is impossible to imagine that this skeleton attained its position in the deposit in which it was found otherwise than during its normal accumulation, and that any idea of an artificial grave having been dug into this stratum is untenable. If these facts be accepted, the remains seem to belong to the Pleistocene period. They do not represent a very early or primitive type, and they thus present a close analogy to the celebrated Ipswich man. The obvious conclusion is that man must have been developed at a period much earlier than is generally supposed. But before this startling conclusion is accepted we must have much more precise details of the geological age of the stratum in which the remains were found. A decision on the question may safely be deferred until Dr. Reck's detailed report is available for study.

PROF. FLINDERS PETRIE contributes to *Ancient Egypt*, part i. of 1915, a valuable article on metals in Egypt, in which he brings together all the available information on the use of copper, gold, silver, lead, tin, bronze, and iron. The account of iron is particularly instructive. First, we have the sporadic Iron Age, beginning with the Gerzeh beads and the well-known piece of sheet iron from the pyramid of Khufu at Gizeh. Incidentally, we are told that the supposition that iron might disappear in course of time is a fallacy. A lump of oxide of iron is practically insoluble when buried, and its strong colouring and staining power make it very obvious. The developed Iron Age in Egypt began about 1200 B.C., whereas in Assyria, iron, as a tribute from the Chalybes, dates from 881 B.C. An Ethiopian source for the Egyptian iron may be discarded, as, if it were common there, it would soon have reached Egypt at a very early date; but the Ethiopian slag-heaps are not earlier than the general special culture of that region, which began in the XXVth dynasty, and continued from 700 B.C. onwards. The sources of the European and Euphratean iron would be quite sufficient to account for the general use of iron in Egypt, even apart from the Ethiopian.

THE picture-film entitled "The Escape," exhibited by Messrs. Ruffell, at the Alhambra Theatre, on Tuesday, possesses scientific interest. Apparently an ordinary melodrama of low life, with an exceptionally well-ordered and pictured scenario, it is designed for educational purposes in eugenics. Many of Zola's and de Maupassant's novels and stories might be thus eugenically underlined. The kinematograph has already done good educational work, *e.g.* in botany and general biology, and there is no reason why it should not develop its usefulness all round the educational field. A long view and some imagination are needed if the average person is to draw the eugenic moral from tragedies of everyday life, but a picture-film interspersed with explanatory mottoes, easily remembered, is a real educative force. The drama deals largely with evil conditions imposed by heredity and environment. A connection is made between them and criminal behaviour, operating both in the home and in public. Selfish luxury is exposed as well as selfish brutality, and the effects on the new generation of the nation's men and women are vividly indicated. A picture-play like this should help many to visualise the scientific reality behind domestic happenings seen daily but ignored.

We have received a report of a bacteriological examination of the milk supply of Montreal in 1913–14, by Dr. F. C. Harrison and Messrs. A. Savage and W. Sadler. A large number of analyses were carried out on more than 1000 samples, and the averages show that Montreal milk, both in summer and in winter, is of very poor hygienic quality. Various recommendations are made with the view of improving the supply.

It is shown by Mr. E. Shaw, in the *Victorian Naturalist* for November, 1914, that two supposed species of Australian cockroaches were founded in 1893 on females of a species named in 1869 from males, and representing a genus apart from that to which the two former were assigned.

In the *American Museum Journal* for December, 1914, Mr. R. C. Andrews records the history of the magnificent collection of whales, porpoises, and dolphins which has recently been brought together in the American Museum, and in the acquisition of which he himself has taken a very large share, having visited whaling-stations in Vancouver, Alaska, Japan, and various Pacific isles, as well as having harpooned white whales during their annual rush up the St. Lawrence. The descriptions of the capture and flensing of the monsters are most vivid, while many of the illustrations are of the greatest interest.

The Report of the Marine Biological Station at Port Erin for 1914 contains a summary of the investigations carried on at the station during the year. Nearly nine million plaice eggs were dealt with in the fish hatchery, of which number about eight million were successfully hatched and the larvæ liberated at an early stage of development. Experiments in lobster rearing were also carried on. Out of 24,500 eggs placed in the hatching boxes, 1823 larvæ were reared to the fourth or "lobsterling" stage. The regular collection of plankton from Port Erin Bay was continued. Biochemical researches on the nutrition and metabolism of marine animals were carried on by Prof. B. Moore and other workers, and various biological researches were also undertaken.

In revising the water-beetles of the group typified by the genus Helophorus in the January issue of the *Entomologist's Monthly Magazine* (the first number of the fifty-first volume and of a nominal third series), Dr. D. Sharp takes occasion to express his objection to the practice of prefixing the letter "H" to derivatives from Greek aspirated words, on the ground that the Greeks did not indicate the aspirate by a letter, and arranged the aspirated and silent vowels in a single alphabetical series. To omit the "H" would, however, destroy all clue to the origin of the words, and in certain instances might lead to difficulty; as, for example, if there were a derivative from ὄρος, a mountain, analogous to horizon, from ὅρος, a boundary. In another article Dr. J. Waterston describes two new species of bird-lice (Mallophaga), representing as many genera, from a Colombian toucan.

Tropical Life for December contains a well-illustrated supplement entitled "Panama and Prosperity," with numerous illustrations of tropical products reproduced from excellent photographs. Coco-nut germination, the picking and curing of cacao, the sugar cane industry, lime-growing, and tobacco in Jamaica are among the subjects illustrated, and should prove of value to those interested in tropical vegetation.

In the *Kew Bulletin*, No. 9, a new oil seed from South America, *Osteophleum platyspermum*, Warb., is described and figured, and an analysis given of the kernel, which contained 55·2 per cent. of fat. Other members of the Myristicaceæ are known to yield yellowish fats containing a large proportion of the glyceride of myristic acid. These seeds, could they be imported in sufficient quantity, would be valuable for commercial purposes.

The Report of the Botanic Station in the Virgin Islands for 1913–14, just received, shows that in these small islands, as in the larger islands under the jurisdiction of the Imperial Department of Agriculture for the West Indies, important work is being done in the improvement of the cultivated crops. The cotton industry, in particular, is well-fostered, and the usefulness of the station is shown by the large demands received for coco-nuts, coffee plants, bay plants, etc. Special attention is being paid to the coco-nut industry, and its progress will be eagerly watched, especially by those owning land in the islands.

The Annotated List of Flowering Plants and Ferns of Point Pelee, Ontario, forming Memoir 54 of the Biological Series, Department of Mines, Canada, is a useful compilation, since Mont Pelee lies on a direct line of north and south bird migration. The object of the paper is to throw light on bird migration and also to add to the knowledge of the distribution of the wild plants of Ontario and Michigan. 583 species of plants were noted on the point. On Pelee Island, a large island to the south in Lake Erie, the Kentucky coffee tree and other plants reach their northern limit. It is unfortunate that Mr. Dodge does not summarise his results or draw any conclusions as to the dispersal of the plants by migratory birds.

The "Fern ledges" of St. John, New Brunswick, form the subject of Memoir 41 of the Geological Survey of Canada, by Dr. M. C. Stopes. These deposits are now recognised as Carboniferous, though formerly described as Devonian, and consist of alternations of sandstones and shales, and it is in the shales that the rich flora of débris occurs. The shales contain impressions of Calamites, Cordaites, etc., and the plants have been for the most part described by Sir William Dawson. A new genus, Pteridospermostrobus is described, the plant being allied to the British Lagenostema, but the preservation is unforfunately very imperfect. The monograph is illustrated by a fine series of plates and useful text figures.

The annual report of the Philippine Weather Bureau (parts 1 and 2), recently issued under the direction of the Rev. J. Algué, S.J., contains hourly observations made at the Manila Observatory during the calendar year 1912. There is but little variation in the mean values from year to year, and nothing exceptional occurred during the year in question beyond an increase in seismic activity; *e.g.* the annual departures from the normal of forty-eight years were, for temperature, −0·15°C.; rainfall, +3·8 mm.; it is therefore unnecessary to add to the remarks made in our previous issues. During the fiscal year 1911–12 the earthquakes reported from various parts of the archipelago numbered 230, 90 per cent. above the average. Only five of the shocks were severe; that of July 12, 1911, has been registered all over the world with the characteristics of a "great earthquake." The Manila seismographs recorded 318 disturbances. The relations with other services in the Far East have recently been much improved; the observations are now synchronous, and although not yet simultaneous, the construction of synoptic charts from available data is much more satisfactory.

IN the *Museums Journal* for December Mr. Alan Pollard advocates the practical use of Cartesian co-ordinates for locating objects in a museum or other rectangular room. He suggests that a foot may be a convenient unit for the purpose, and that a rough scale may be sufficient for purposes of localisation, the *centre* of the object being the point specified. As it is necessary to specify which faces of the room are to be taken as co-ordinate planes, the author proposes, the wall containing the door by which the room is entered as plane of (x, z), and the wall to the left of this as plane of (y, z). For a line or plane parallel to one edge or face of the rooms, he proposes to specify numerically the given co-ordinates using letters for the indeterminate ones; for example $(x, 29, z)$ represents a wall 29 ft. from the plane of (x, z).

THERE is a growing tendency among postgraduate students, and indeed mathematical writers generally, to produce papers containing no new ideas, but merely clothing ideas already familiar to readers in slightly different form or notation. As examples we may illustrate the waste of university endowments on students who merely propose to express well-known formulæ of electrostatics or attractions by means of quaternions and elliptic functions. Mr. George Paswell contributes to the Bulletin of the American Mathematical Society for December "An Appeal to Producing Mathematicians" which we hope will be read in very great earnest by all teachers of advanced students and writers of papers. He points out that the profession of civil engineering is teeming with problems awaiting the solutions of a Laplace or a Newton, and he instances the theory of elasticity as requiring the most urgent attention. He further attacks the shallowness of the courses of mathematical instruction given to applied science candidates, and though his strictures apply particularly to America, it is equally true that in Great Britain candidates can obtain University degrees in engineering on work that is scarcely up to intermediate pass standard. A paper by Mr. Sidney Withington on the catenaries of one of the American trolley railways in the Journal of the Franklin Institute for December, 1914, illustrates this point well. The author on page 721 employs the binomial theorem with a reckless waste of neglected terms to prove or rather to fail to prove an obvious geometrical result which he can only accomplish by inserting or omitting a factor 2 from one or other of two quantities to be proved equal, the explanation of this factor being quite different from anything clearly and explicitly stated in the paper. While strongly supporting Mr. Paswell's plea, we greatly regret that he has omitted the subject most urgently requiring research at the present time, viz., aeroplanes. Aeroplane problems are running to waste by the dozen, and they practically never, or at best rarely, figure in mathematical transactions.

THE *Electrician* for December 25, 1914, reproduces the provisional report of the committee of the Physical Society on Nomenclature and Symbols. Some of the most noteworthy features of the report are its proposal to use capitals for the amplitudes, and small letters for the instantaneous values of quantities varying harmonically; its restriction of the termination -ity to specific, and its use of the termination -ance for non-specific, properties. Thus we have the resistance, conductance, and inductance of an electric circuit, but the resistivity, conductivity, and permeability of the material of which it is composed. The term capacity of a condenser is, however, retained, and forms an exception which might be got rid of by the substitution of the word capacitance. In terrestrial magnetism and atmospheric electricity the terminologies are in a chaotic state, and the evil is not likely to be mitigated so long as colourless words like declination and inclination are adopted by theoretical writers for the effects graphically described by the words deviation of the compass and dip respectively. It is much to be desired that the various committees now considering the question of symbols should confer with each other in order if possible to introduce unanimity into their reports (see p. 544).

UNDER the title "Chemistry and Practical Life" has been reprinted an address delivered by Dr. G. T. Beilby before the Chemical Society of the Royal Technical College, Glasgow. Whilst fully recognising the great indebtedness of modern civilised society to science and its discoveries, Dr. Beilby emphasises the enormous debt which had already been incurred to the countless generations of workers who had lived and worked before the advent of chemical science. In reviewing the position of chemical industry in this country, a subject on which Dr. Beilby speaks with authority, it is pointed out that "long after the scientific development of chemical engineering was well under way in Germany, scientific and academic chemists completely ignored the necessity for this new hybrid, the 'chemical engineer,' or openly scoffed at the idea." Too frequently in the colleges of this country "there appears to be an absence of any real conviction that the call for instruction in chemical science with a deliberate view to its application in the development of the arts and industries is intrinsically sound from the intellectual as well as from the practical point of view." A letter by Mr. C. R. Darling in the Journal of the Society of Arts (December 18) emphasises in a similar way the fact that "if we are to have that co-ordination between the teacher and manufacturer that exists in Germany to the great advantage of both, the teaching of chemistry must not, as at present, be mainly confined to the cloister. We must either introduce courses of instruction in industrial chemistry into our existing colleges and universities, conducted by men of experience, or create new institutions for the purpose. So long as educational authorities regard the possession of a degree as the only criterion of ability, and form their staffs almost exclusively of men who have had no industrial experience, they will never give that effective assistance to the manufacturers which will enable us to hold our own in the sphere of chemical industry."

AMONG the various uses to which oils are put is their employment by electrical engineers for the insulation of oil-immersed transformers and for surrounding the breaking contacts of high-tension switches. Special qualities of oil are necessary and a good deal of research has been going on as to the selection and testing of suitable oils for these purposes. A quantity of information has been collected by a research subcommittee of the Institution of Electrical Engineers, and is embodied in a report just issued. The chief troubles are the deterioration of the oil by the gradual formation of sludge and the lowering of its quality as a dielectric by the absorption of moisture. This sludge now appears to be due to the formation of complex organic acids, dehydrogenated hydrocarbons, and oxidised resinous asphaltones of the mineral oil originally used. The formation of these compounds is accelerated by increase of temperature, and for testing purposes they can be rapidly produced by exposing the oil to ozone. The effect of sludging, although impeding the required circulation of oil in a transformer, does not affect its dielectric quality so much as the absorption of moisture, and this is so serious that the presence of a small percentage of water in the oil is more easily detected by electrical tests than by purely chemical methods.

HITHERTO the manufacture of the well-known antiseptic, thymol, has been practically confined to Germany, notwithstanding the fact that ajowan seeds, the oil from which is almost the sole source of commercial thymol, are grown on a large scale only in India, which has thus been supplying Germany with the raw material of a valuable industry. No further supplies of thymol being forthcoming from Germany owing to the war, the price had increased almost eight-fold by September last, and is even now 21*s*. 6*d*. per lb., as against 5*s*. per lb. before the war. There is every reason why the United Kingdom should now become the chief centre of the manufacture of thymol. The manufacturing process is quite simple, and ample supplies of ajowan seed are available in India. The Imperial Institute, which has devoted attention to this subject, has now made inquiries in India, and is prepared to put intending British manufacturers of thymol in touch with Indian exporters of the seed. Fortunately, too, a British possession can provide a substitute for thymol if such be required. This substance is carvacrol, which is obtained from oils derived from a variety of plants, but particularly from the origanum of Cyprus. At the instance of the Imperial Institute this Cyprus origanum oil is already being produced in commercial quantities from wild plants in Cyprus, and in 1913 was exported thence to the United Kingdom to the value of 980*l*. It is believed that the plant can be cultivated profitably and on a large scale in Cyprus, and experiments in this direction are understood to have been begun.

THE first report of the Board of Trade Committee on bulkheads and water-tight compartments, presided over by Sir Archibald Denny, has now been issued, and forms the subject of the leading article in *Engineering* for January 8. The committee has now been at work for nearly two and a half years, and the first report deals with foreign-going steamers carrying more than twelve passengers. It is not possible even to mention all the points covered by this comprehensive report, but we note that the committee has given a clearly defined method for the construction of flooding curves and tables. Full calculations were made for several actual vessels of widely different types, and from these, together with the general laws governing flooding calculations, a method of preparing flooding curves from simple data was devised. The method was tested by applying it to a number of actual vessels, and comparing the results with those given by full flooding calculations for the same vessels. The Committee is right in claiming that the formulation and enforcement of rules governing subdivision is a contribution of the utmost importance to the subject of safety of life at sea.

WE have received an interesting pamphlet from the Bonecourt Waste Heat Boiler Co., Ltd., of Parliament Mansions, Westminster, in which is described a method of raising steam for power, heating, or other purposes by utilising the heat carried away in the products of combustion of internal-combustion engines and metallurgical furnaces. In general, the exhaust gases from an internal-combustion engine contain from 30 to 45 per cent. of the total heat available in the fuel supply, and these gases leave the engine at a fairly high temperature. In the Bonecourt system the exhaust gases from the engine are passed through internal tubes in a small steam boiler. At full engine load it is claimed that from 3 to 3·5 lb. of water can be evaporated from and at 100° C. per hour per brake-horse-power of the engine, with no additional cost for fuel. In other types of boiler made by the firm, both fuel firing in an ordinary grate and heating by exhaust gases are combined. Small tubes take the products of combustion from the coal-fired grate and separate larger tubes in the same boiler receive the engine exhaust gases. A boiler 7 ft. in diameter by 6 ft. long would be suitable for a 500 brake-horse-power gas engine, and would evaporate 1500 lb. of water an hour from and at 100° C. from the heat in the exhaust gases alone. Alternatively it would evaporate the same quantity when fired with coal alone, and if worked simultaneously by both methods, the evaporation would be about 3000 lb. an hour from and at 100° C. A large increase in efficiency is claimed by application of the system to open-hearth furnaces.

THE forty-second annual issue, that for 1915, of "Willing's Press Guide and Advertisers' Directory and Handbook" has been received. This yearly book of reference provides a concise and comprehensive index to the Press of the United Kingdom, a list of telegraphic news and reporting agencies, lists of the principal Colonial and foreign journals, and a variety of general information. A classified index of periodicals will prove of special interest to librarians, who, under such titles as "Chemical Science," "Geology," "Astronomy," "Philosophy," will find lists of magazines and journals devoted to different branches of science. The price of this useful "guide" is 1*s.*

OUR ASTRONOMICAL COLUMN.

FIREBALLS IN JANUARY.—Though January is by no means a month presenting special meteoric activity, it has furnished quite an unusual number of large fireballs. An analysis of the dates appears to show that the following periods are rather strikingly indicated:—

Principal Radiants.

Jan. 1–4	230° + 52°		
9–13	57° − 12°	120° 0°	133° + 21°
14–19	110° + 23°	130° + 33°	130° + 48°
25–28	132° + 31°	160° + 58°	332° + 57°

The January fireballs deserve more careful observation and inquiry. There are evidently some rich showers involved, but it is very difficult from the limited state of our knowledge, to single out the richest systems from the large number which apparently supply our January meteors. Apart from the several radiants mentioned above, there are many others fairly well defined in Aries, Taurus, Perseus, Leo, Virgo, Gemini, and Ursa Major. The data already collected appear to prove that the prevalence of large meteors is due rather to a considerable number of showers than to the special activity of two or three, but the investigation can be carried still further when additional materials have accumulated.

THE CAPTURE THEORY OF SATELLITES.—Prof. T. J. J. See's volume entitled "Researches on the Evolution of the Stellar Systems" (vol. ii., "The Capture Theory"), is discussed by Dr. A. C. D. Crommelin in the current number of *Scientia* (vol. xvii., 1915.) Prof. See's contention is that the planets and satellites were independent of the solar system, and have never been evolved from what we consider their primaries, but that they have been captured from outside and made to conform to their present orbits under the secular action of a resisting medium. Dr. Crommelin holds to the view that the matter embodied in the planets was always a part of the solar system, but spread out in the form of huge dust clouds, which finally condensed round certain centres. It is in support of this view that the present article was written, and he brings forth many lines of argument which help to strengthen his view. Dr. Crommelin states that his conclusions do not imply any want of respect for Prof. See's contributions to astronomical theory, for "his suggestions are always stimulating and ultimately help on the attainment of the truth." The new light that the study of the spectroscopic binaries has shed on the question calls nevertheless for a modification of his views.

OBSERVATIONS OF THE MOON.—Prof. W. H. Pickering, in the November number of *Popular Astronomy* (vol. xxii., No. 9, 1914) described some interesting observations on the lunar crater Aristillus, and incidentally made some general statements which no doubt have attracted attention. He points out that nearly everyone who looks at the moon through a telescope confines his attention to those regions near the terminator because they furnish "striking views, are easily identified, and because what is seen is easy to understand." It is for this reason, he says, that the impression that the moon is lifeless has so long maintained its existence. According to him the only time when the moon is really interesting is when its surface is viewed far away from the terminator, that is, during the lunar summer time, for then changes are taking place, changes which are "conspicuous all over the surface to any who will take the trouble to watch and to study them carefully." Here, he suggests, is the opportunity for the amateur to come in, to make his observations and drawings with care, to record the times, compute the corresponding colongitudes, and to publish his results. The necessary observations do not require the highest grade of seeing nor the largest telescopes. Close observation has led Prof. Pickering to conclude that the moon is very far from being a dead planet, and he has advocated the existence of vegetation on the moon for more than twenty years; he hopes by means of the above assistance that his idea will gain ground, and that the textbooks of twenty years hence will not contain the statement that "the moon is without air, water, or vegetation."

COMPANION TO "THE OBSERVATORY" FOR 1915.—The Companion to *The Observatory* for the present year has just come to hand, and its contents are familiar to astronomers, both professional and amateur. The substance of the matter and its arrangement follows for the most part on the lines of former issues. One important alteration is the page devoted to meteor radiants. This year the principal radiant is given for each night during the year, as well as the average hourly number of meteors visible on a clear moonless night. This information is supplied by Mr. W. F. Denning from observations made between 1866 and 1914. Only two eclipses will occur during the year, and these are both annular eclipses of the sun; neither will be visible in Europe.

THE METEOR-FALL OF ENSISHEIM (1492).—A reprint from the Journal of the Royal Astronomical Society of Canada (September-October, 1914) contains some interesting historical references to the meteor-fall of Ensisheim, which occurred in Alsace in 1492. These notes have been brought together by Dr. C. A. Chant in the hope of clearing up several discrepancies between different authorities. According to Wulfing's work on meteorites in collections and literature, sixty-five museums are supposed to possess portions of this meteorite, the original weight being 127 kg. (279 lb.), of which 70·4 kg. have been located. Ensisheim is the fortunate possessor of 54·8 kg., which is preserved in the town hall.

CHEMICAL TESTS AND STANDARDS.

AS is well known, the Bureau of Standards of the U.S. Department of Commerce[1] issues from time to time circulars and technological or scientific papers upon various matters which have come before it for investigation. Among a budget of these publications received recently are papers dealing with the questions indicated below.

In Technologic Paper No. 31, Mr. E. T. Montgomery describes experiments made with "Some leadless borosilicate glazes maturing at about 1100° C." In ceramic practice glazes containing lead have certain advantages, but are often potentially poisonous. The object of the experiments was to make a general comparison between lead glazes and leadless glazes for white ware and china at a firing temperature of about 1100° to 1120° C. Seger's work on leadless glazes was taken as the basis. The author concludes that both kinds have special faults and special virtues, but it is not likely that any leadless glaze will be found "which will exactly duplicate the many excellent properties" of glaze containing lead as an ingredient.

Paper No. 33 describes a method of determining the carbonic acid, obtained from the combustion of carbon in iron, by converting it into barium carbonate and titrating this salt. This avoids certain errors to which the use of potash bulbs or soda-lime tubes for weighing the carbonic acid is liable. The principle of the process is well known; the point of the paper lies in the details given for obtaining accurate and fairly rapid results.

In Paper No. 35 Mr. L. G. Wesson explains a "combustion method for the direct determination of rubber." It consists in converting the rubber into a nitrosite, which is then dissolved out with acetone, and a combustion analysis made upon an aliquot part of the solution after expulsion of the solvent. The process promises to be a useful one.

The "Scientific Paper" (No. 221) is a discussion of the "influence of atmospheric conditions in the testing of sugar." During the operations of clarifying and filtering solutions of sugar for polarimetric examination, the liquids, if not kept covered, lose water by evaporation. The concentration of the sugar is thus increased, and the polarisation-value rendered too high. The magnitude of this effect, and the conditions modifying it, have been investigated by the authors of the paper. By keeping the liquids covered during the operations practically all increase in the polarisation-value may be prevented.

Of the "Circulars" in question one (No. 16) is a small pamphlet which describes the testing of hydrometers as carried out by the Bureau of Standards, and gives instructions with a view of promoting uniformity in the construction and verification of these instruments. The other (No. 44, "Polarimetry") treats of the principles which underlie the construction and use of the polariscope and the analysis of sugars. It is written from the point of view of the standards department, and deals at some length with the different systems, scales, and sources of illumination employed in modern polarimetry. This publication is distinctly of value both to polariscope makers and to sugar analysts.

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[1] Bureau of Standards. Technologic Papers, Nos. 31, 33, 35: Scientific Paper No. 221; Circulars Nos. 16, 44.

WAR AND THE RACE.

THE Manchester Statistical Society has printed an eloquent address by Dr. C. W. Saleeby, "The Longest Price of War." The thesis is the old, but politically ignored, result of war in "reversed selection." Quoting Michelet's epigram that the campaigns of Napoleon lopped a cubit from the stature of the French, and Prof. J. A. Thomson's observation that not even the discoveries of Pasteur could restore the physique which the victories of Napoleon's armies had destroyed, Dr. Saleeby notes the small size of the present-day French soldier, as remarked by many observers. To-day, for our own forces, "the brave, the vigorous, the healthy, the patriotic are taken, and the others left. . . . The rejected recruits recruit the race." The whole question is one which statisticians should investigate in special reference to the present war. Dr. Starr Jordan's study, "The Human Harvest," and the late J. Novikow's "Darwinisme Sociale," are the best of a meagre list of popular expositions of the thesis, of which the decay of the Roman Empire is the classic type. Speeck estimated that of every hundred thousand Romans, eighty thousand were slain. "Vir" thus gave place to "homo"; "the Roman Empire perished," says Seeley, "for want of men."

No scientific mind wishes to eulogise war, in the German fashion, which depends for its argument on the primitive athletic form of war, whereas war of to-day is simply peace riddled with casualties. Darwin's famous sentences refer only to a more or less imaginary conscript army in a country which is always at war—"in every country in which a large standing army is kept up, the finest young men are taken by the conscription or are enlisted. They are thus exposed to early death during war, are often tempted into vice, and are prevented from marrying during the prime of life. On the other hand, the shorter and feebler men, with poor constitutions, are left at home, and consequently have a much better chance of marrying and propagating their kind." It seems a fairly obvious inference that the dysgenic results of modern warfare remain to be proved. The deliberate sacrifice of life by exploiting the mass-formation is a special case needing investigation. The whole subject calls for investigation; until this is carried out, nothing is at all clear either for or against the biological effects of war.

STANDARDISATION OF ELECTROTECHNICAL SYMBOLS.

THE International Electrotechnical Commission has recently issued its report (Publication 27[1]) upon international symbols in electrotechnics. In the preface to the report, it is pointed out that the subject of international agreement in regard to symbols employed in electrotechnics was first brought before the International Electrotechnical Commission at its meeting in London in 1908. In Brussels, in 1910, a few general rules, together with a certain number of symbols, were adopted for circulation to the various national committees. The question of international agreement in regard to the symbols for the algebraic representation of Ohm's law was briefly mentioned, with the result that the following year, at Cologne, certain definite proposals were made by Dr. E. Budde, president of the German committee, which culminated in international agreement being reached in this important matter at the plenary meeting of the commission held in Turin in September, 1911. At the latter meeting a number of other proposals were provisionally adopted, and a special committee was instituted to continue the work and draw up further proposals to be placed before the national committees for their consideration. At the plenary meeting of the Commission held in September, 1913, at which twenty-four nations were represented, the final recommendations were ratified as given in the report here reprinted. An article on the proceedings of that meeting appeared in NATURE of September 25, 1913 (vol xcii., p. 109).

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[1] London: Published for the Commission by Waterlow and Sons, Ltd., and to be obtained from the General Secretary, 28 Victoria Street, Westminster, S.W. Price 2s. 1d. post free.

Introductory Remarks on the Standardisation of Symbols.

In so far as electrotechnics alone are concerned, it would seem possible to standardise symbols, and the following principles have served as the basis of the work of the special committee in the attainment of this object:—

The symbols must be clearly distinguishable one from another when writing with a pen on paper, with chalk on a blackboard, or with a typewriter. In the printed text, it is advisable to use a different type for the symbols from that of the text. It is desirable also that in ordinary handwriting, one should not be obliged to add distinctive signs to symbols to specify the type to be employed. It should be possible to spell out the symbols when writing them on the blackboard. Finally, preference should be given to those symbols already in common use. From this it will be seen that it is impossible to make a distinction, in ordinary handwriting, between Roman letters and italics, and that small roundhand letters, being too difficult to differentiate from the above, cannot be used. It is generally agreed to abandon Gothic type, as requiring too long a time in writing. Finally, many of the Greek capitals are identical with Roman capitals. Taking the above points into account, there remain about one hundred symbols available in Roman, Script, and Greek type, of which several are already used for mathematical symbols and which are necessary for the purposes of the electrician. A list of symbols most frequently needed in electrotechnics is appended herewith. Taking into account certain symbols which are occasionally made use of, it is obvious that there will be none left for purely physical or mechanical quantities. Thus, in the same formula, electrotechnical symbols may occur in conjunction with other symbols used in mechanics and physics generally; this is especially the case in equations containing mass, moment of inertia, speed, density, temperature, quantity of heat, etc. The I.E.C. recommends, therefore, that in such cases, for physical and mechanical quantities, the symbol habitually used by physicists and mechanical engineers should be employed, if this symbol does not already exist in the formula as an electrotechnical symbol. If, on the contrary, it already exists in the formula, it is desirable that it be accompanied by a distinctive sign or that the notation be changed.

Rules for Quantities.

(*a*) Instantaneous values of electrical quantities which vary with the time to be represented by small letters. In case of ambiguity, they may be followed by the subscript "t."

(*b*) Virtual or constant values of electrical quantities to be represented by capital letters.

(*c*) Maximum values of periodic electrical and magnetic quantities to be represented by capital letters followed by the subscript "m."

(*d*) In cases where it is desirable to distinguish between magnetic and electric quantities, constant or variable, magnetic quantities to be represented by capital letters of either script, heavy-faced, or any special type. Script letters to be only employed for magnetic quantities.

(*e*) Angles to be represented by small Greek letters.

(*f*) Dimensionless and specific quantities to be represented, wherever possible, by small Greek letters.

TABLES OF SYMBOLS ADOPTED.

I.—*Quantities.*

NAME OF QUANTITY	SYMBOL	Symbols recommended for the case in which the principal symbol is not suitable	
1. Length	l	In dimensional equations the capital letters L, M, T, are to be employed	
2. Mas	m		
3. Time	t		
4. Angles	$\alpha, \beta, \gamma \ldots$		
5. Acceleration of gravity	g		
6. Work	A	W	
7. Energy	W	U	
8. Power	P	[*]	
9. Efficiency	η		
10. Number of turns in unit of time	n		
11. Temperature Centigrade	t	θ $\mathfrak{T}$	
12. Temperature absolute	T	Θ	
13. Period	T		
14. $2\pi/T$	ω		
15. Frequency	f	ν[†]	
16. Phase displacement	ϕ		
17. Electromotive force	E		
18. Current	I		
19. Resistance	R		
20. Resistivity	ρ		
21. Conductance	G	[‡]	
22. Quantity of electricity	Q		
23. Flux-density, electrostatic	D		
24. Capacity	C		
25. Dielectric constant	ϵ		
26. Self-inductance	L	$\mathfrak{L}$	Script, heavy-faced, or special type
27. Mutual inductance	M	$\mathfrak{M}$	
28. Reactance	X	$\mathfrak{X}$	
29. Impedance	Z	$\mathfrak{Z}$	
30. Reluctance	S	$\mathfrak{R}$	
31. Magnetic flux	Φ	$\mathfrak{F}$	
32. Flux-density, magnetic	B	$\mathfrak{B}$	
33. Magnetic field	H	$\mathfrak{H}$	
34. Intensity of magnetisation	J	$\mathfrak{J}$	
35. Permeability	μ		
36. Susceptibility	κ		

[*] A symbol for the second column is to be supplied by the Austrian and German Committees jointly and inserted without further discussion by the I.E.C.

[†] This symbol will be omitted if the Austrian and German Committees agree to do so.

[‡] A symbol for the second column is to be supplied by the Austrian and German Committees jointly and inserted without further discussion by the I.E.C.

The German delegate made a reservation in regard to the symbols 13, 14, 20, 23, 25, 27 to 31, which are not so far accepted in Germany, but did not oppose the adoption of these symbols by the I.E.C.

II.—*Units. Signs for Names of Units.*

Signs for names of electrical units to be employed only after numerical values :—

NAME OF UNIT	SIGN
1. Ampere	A
2. Volt	V
3. Ohm	*
4. Coulomb	C
5. Joule	J
6. Watt	W
7. Farad	F
8. Henry	H
9. Volt-coulomb	VC
10. Watt-hour	Wh
11. Volt-ampere	VA
12. Ampere-hour	Ah
13. Milliampere	mA
14. Kilowatt.	kW
15. Kilovolt-ampere	kVA
19. Kilowatt-hour.	kWh

m	sign for milli-	μ	sign for micro- or micr-
k	sign for kilo-	M	sign for mega- or meg-

* As a sign for the ohm, one of the two letters O or Ω is provisionally recommended. The letter Ω should no longer be used for megohm.

III.—*Mathematical Symbols and Rules.*

NAME	SYMBOL	Symbols recommended for the case in which the principal symbol is not suitable
Total differential	d	d
Partial differential	∂	
Base of Napierian logarithms	e	ϵ
Imaginary $\sqrt{-1}$	i	j
Ratio of circumference to diameter	π	
Summation	Σ	
Summation, integral	$\int$	

1. Ordinary numerals as exponentials shall exclusively be used to represent powers. (In consequence, it is desirable that the expression $\sin^{-1}x$, $\tan^{-1}x$, employed in certain countries be expressed by arc $\sin x$, arc $\tan x$.)

2. The comma and the full-stop shall be employed for separating the decimals according to the custom of the country but the separation between any three digits constituting a whole number shall be indicated by a space and not by a full-stop or a comma (1 000 000).

3. For the multiplication of numbers and geometric quantities, indicated by two letters, it is recommended to use the sign ×, and the full-stop only when there is no possible ambiguity.

4. To indicate division in a formula, it is recommended that the horizontal bar or the colon be employed. Nevertheless the oblique line may be used when there is no possibility of ambiguity; when necessary, ordinary brackets ( ), square brackets [ ], and braces { } may be employed to obtain clearness.

IV.—*Abbreviations for Weights and Measures.*

Length :—m; km; dm; cm; mm; μ=0·001 mm.

Surface :—a; ha; m^2; km^2; dm^2; cm^2 mm^2.

Volume :—l; hl; dl; cl; ml; m^3; km^3; dm^3; cm^3; mm^3.

Mass :—g; t; kg; dg; cg; mg.

V.—*Name for Electrical Unit.*

The I.E.C. will recommend to the International Congress of the Applications of Electricity, to be held in San Francisco in 1915, the adoption of the name "Siemens" for the unit of conductance.

GERMAN METHODS IN COMMERCE.

A PAPER on the organised methods employed by Germany in commerce, prepared by Sir William Ramsay for the Institute of Industry and Commerce, was referred to in a paragraph in NATURE of December 24 (p. 457). By permission of the institute, the article is here reprinted in full.

It has not been generally known that in commerce, as in war, the methods employed by Germany have been completely organised for many years. Instead of looking on commerce as an arrangement for mutual benefit, the German nation has regarded it as a war, And just as in the present war all methods of attack are regarded by the military advisers of Germany as legitimate, so we are slowly awaking to the knowledge that German commercial and industrial methods have for years been aggressive. The war in which we are now engaged is, indeed, a war for the liberation of nations from commercial and industrial brutality, as well as for their deliverance from an attempted enslavement to German "Kultur," as exemplified by the practices of their army.

At the annual meeting of the Society of Chemical Industry in 1903 I pointed out that the German military organisation had its counterpart in their commercial organisation; that there exists an Imperial Council whose proceedings are kept quiet, but which takes into consideration all obtainable statistics, and as far as possible legislates, or endeavours to legislate, on the basis of these statistics. Where fiscal duties are found to be required, such a council puts them on; where there is an advantage in taking them off, they are removed. Where cheap transit is possible they give it; for the railways are the property of the State. I then said :—"Is it to be expected that any country can fight such a combination as that without adopting, at all events, something of their methods, or without studying their methods, and without combining together, if not to imitate them, at least to thwart them? There is a military campaign against us, and we must defend ourselves."

The competition in the colour trade, for instance, has almost prohibited the manufacture of dyes in England. In Germany the management is in the hands of well-trained men, who, aided by an efficient staff of engineers and chemists, are continually engaged on the problems of utilising any discovery made in their own laboratories or elsewhere, and making it commercial, whether by securing cheap raw material, cheapening the process of manufacture, or creating a public demand for the object to be manufactured. Agencies are maintained all over the world whereby the article is introduced to the notice of foreign purchasers; and an extensive credit system is encouraged. All this is legitimate; but the maintenance of a trained legal staff, not merely to advise as to the validity of patents, but to advise whether the infringement of another's patent is likely to be successful, and whether it may not be possible, by infringing a patent, so to saddle an opponent with legal expenses as to break his competition, is not easily defensible. Fair competition between individuals lies at the bottom of all trade; unfair competition, backed by all the resources of the State, is what we have had to face with Germany.

We have recently had brought to our notice German methods applied to the shipping industry, and the Australians have been pointing out that the control of the "base metal market" is almost entirely in German hands.

It is necessary to go further; just as the German State has shown itself to be no respecter of treaties, just as the leaders of the German army have revealed themselves as breakers of every humane law, treacherous and deceitful, so long as they think they can gain their ends, so it is foolish not to be warned that the German nation as a whole, is completely unworthy of trust; that commercial agreements are regarded by members of that nation as binding only so long as some advantage is to be gained by keeping to them, and that dishonesty is excusable if only it appears to lead to German prosperity. For there is a sort of debased patriotism in the average German mind, "Deutschland, Deutschland über alles, über alles in der Welt," no matter how the supremacy of "Deutschland" is secured.

We were shocked at the beginning of the war by the disregard towards treaties displayed by our opponents; we were amazed at the treatment of Belgian non-combatants; and we are slowly realising that every trick, from firing on the Red Cross to the false display of the white flag of surrender, is made use of by the enemy, and not, be it observed, by individual groups of our opponents, but by command from high quarters. We are slowly and incredulously awakening to the knowledge that German commercial tricks are on a par with their tricks in war: that the whole nation is infected by the microbe of dishonour and dishonesty.

Of course, there are honest men among our opponents; from time to time we read of kind acts to our wounded; and from a lifelong experience of Germany and the Germans I have no hesitation in stating there are Germans as kindly, as honest, and as upright as there are among ourselves, the French, the Americans, and among the inhabitants of all other nations. That is not the point. What we have to face is a nation organised for a policy of dishonesty; and a nation which, as a nation, approves of that policy. Moreover, this nation believes that the policy of dishonesty is likely to be a successful one, and it has the will, and believed itself to have the power, to enforce this policy on the whole world. Conscientious Germans have been impressed more by the end than by the means adopted to gain that end: the prosperity of their "Vaterland."

I conceive that the main purpose of the Institute of Industry and Commerce is to take counsel and evolve some means for combating this attack. Just as it is clear that peace can never be declared until the chance of another Teutonic outburst is made impossible, by the total disbandment of the German army, so it must be evident that the commercial system of Germany cannot be allowed to continue. It is probable that it is better to make a beginning by an alliance of science, industry, and commerce, such as the institute contemplates; but it will be necessary, if the future German State is allowed to retain the power of waging an industrial war, to combat it by the action of the organised British nation, that is, by the State. Once that conquest is achieved, however, we should do well to remember that commerce should be co-operative and not competitive; that it is to our interest not only that we ourselves should prosper, but that others should also prosper; that, indeed, our own prosperity is bound up in the prosperity of our fellow-creatures.

WILLIAM RAMSAY.

STATE AID FOR SCIENCE.[1]

Introductory.

ELEMENTARY education and the training of teachers for work in elementary schools have been the object of State solicitude for the past eighty years. Increasing sums of money have been devoted to these two purposes; rules and regulations in rich variety have been framed for the proper disposal of this money, and some of the ablest and most energetic administrators have spent their lives in the endeavour to carry them out; a vast system of officials and organisations has arisen to see that no possible flaw or fault remains in the effective distribution of the sums annually voted by the State; and yet the general consensus of opinion among those best qualified to judge is that the results achieved are very poor, that they are transient in effect and occasionally even harmful rather than beneficial. Gigantic efforts have been and are being made, yet the results are plainly incommensurate with the outlay; very few indeed being satisfied that the State and the locality are getting money's worth for their expenditure.

This then being the present position as regards the problem of elementary education let us now see how far the same position is true in regard to the small portion of the State's annual expenditure on education of all types and degrees which is specifically earmarked for the promotion of science teaching, scientific training, and research. It may perhaps turn out to be true that the ineffectiveness of much of our educational system is due to the absence of the scientific spirit among our administrators and teachers, to lack of definite knowledge of the capabilities of the child mind, and neglect of the conclusions which science, if properly studied, could have supplied.

Taking as the basis of our investigations the various sums voted by the State for the promotion of science during the past sixty years, we can from the variations in the amounts, and in the particular objects for which these amounts were granted, observe how the encouragement given to science has fluctuated. For this purpose the Estimates annually presented to Parliament are the most trustworthy guide—a guide who, however, frequently leads one astray.

The task of following any particular item of the Vote from year to year is rendered difficult from the various reorganisations and rearrangements occasioned by the changes made from time to time in the organisation of the various offices, as, for example, when the control of science instruction in Scotland was transferred to the Scottish Education Department in 1897–8, and that for Ireland in 1899–1900 to the Board of Agriculture and Technical Instruction. Nor is this the only source of confusion. Sub-heads dealing with science are sometimes kept separate from and sometimes amalgamated with those relating to art, so that it is not possible to say with certainty whether a particular form of aid has increased, diminished, or disappeared.

This difficulty becomes accentuated in the year 1900, when the Science and Art Department became amalgamated with the Education Department, and the two started anew on their official career as the Board of Education. In subsequent Estimates votes were rearranged, amalgamated, or split up until their history can no longer be followed with accuracy.

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[1] Abridged from a paper read before Section L of the British Association at Melbourne, by C. A. Buckmaster.

It will thus be seen that the determination of the exact amount contributed by the State for the furtherance of science is not altogether an easy matter. Moreover it cannot be settled by turning to Class IV. of the Estimates, which deals with the amount allotted for education, science, and art—three subjects probably entirely distinct in the official mind. For in Class II. of the Estimates dealing with public offices there will be found under the head of the Board of Agriculture items for agricultural education and for advances to societies for experimental purposes and for research. This is only one example to show that the money voted annually for education, science, and art does not represent the total of the State's assistance either to education or to science. We need not inquire on the present occasion if it is more complete in regard to art.

Again, from time to time the State, goaded into action by outside pressure, grants sums of money for specific scientific inquiries, such as the 1000*l.* allotted in 1873 and following years to the Sub-Wealden Exploration, the 15,000*l.* granted for observing the transit of Venus in 1882, the annual grants for successive years of varying sums from 2000*l.* to 5000*l.* for the Deep-Sea Exploring Expedition in 1877–87. The recent National Antarctic Expedition also received the substantial help of 45,000*l.* The International Geodetic Conference was aided for a number of years, and so also was, and is, the North Sea Fisheries inquiry. These are genuine examples of the aid given by the State for science purposes, but they are from their very nature variable in amount, and not assigned as part of a definite policy of encouraging systematic scientific research as a continuous and necessary part of national organisation. They owe their existence to external forces, and if these were withdrawn or lessened they would disappear.

The grants of this character are generally, but not universally, to be found under Class IX. of the Estimates labelled "Miscellaneous or Temporary."

Another series of grants are to be found under the heading "Public Buildings," where the sums voted for the Natural History Museum, the Royal College of Science, the Edinburgh Industrial Museum, the National Physical Laboratory, the Edinburgh Observatory, and other buildings may from time to time be discovered and their progress followed by noting the sums annually voted towards their commencement, continuation, and completion. These sums also are not voted as part of a settled, thought-out scheme of scientific equipment for the nation, but are granted more or less piecemeal, according to the pressure which can be brought to bear to get a particular vote included in the Estimates.

Class IV. (Education, Science, and Art) does not therefore, include anything like all the State aid given to science, nor does it include all that is given for educational purposes. The War Office Vote includes large sums spent, not merely on the technical training of officers, but also on the general elementary education of the rank and file of the Army, and of their children, both in day schools and in evening classes. Similarly, the Admiralty Vote includes the sums spent on the educational institutions at Osborne and Dartmouth, and less important places. The Vote for educational purposes in the Army Estimates for 1914–15 amounts to more than a quarter of a million, while that for the Navy is slightly less than this amount. Probably a greater proportion of the Navy Vote is spent on science instruction than is the case with the Army. This might naturally be expected. Nor is this all. From time to time a Government Department embarks on a little scientific investigation on its own account. Though started with a purely utilitarian aim, the results cannot but be of some permanent scientific value. The expense attending these investigations must be sought for among the votes taken for the office specially concerned in the inquiry. Such cases will be found under the Public Health Department of the Privy Council, the Chief Secretary for Ireland's Department, the Board of Trade, and the Local Government Board.

For the sake of completeness mention should be made of the sums expended by Royal Commissions and Select Committees, such as the Royal Commission on Scientific Instruction, which was appointed in 1870, that on Technical Instruction in 1881, and the Select Committee to report on the Museums of the Science and Art Department in 1898.

All these have the same characteristic of indefinite variability, and a consideration of their annual fluctuations would lead to no definite result. Without, therefore, ignoring or depreciating the valuable if erratic assistance the State gives from time to time for scientific purposes by providing buildings, appointing commissions, financing expeditions, and carrying out inquiries, it is only by restricting attention to the sums voted year by year in pursuance of a more or less settled scheme that we can truly determine if science instruction is really increasing in volume and effectiveness, and is being made more and more available for all who could derive profit from it. In this connection it may be worth while to recall the words of the Queen's Speech in 1853:—"The advancement of the fine arts and of practical science will be readily recognised as worthy the attention of a great and enlightened Nation, and I have directed that a comprehensive scheme should be laid before you having in view the promotion of these objects towards which I invite your aid and co-operation."

The Rise and Fall of the Science and Art Department.

Before the first International Exhibition of 1851 State aid to education of any type had been practically restricted to an annual grant for elementary schools, which in 1850 had reached the modest sum of 125,000*l.*; to a grant to the University of London of about 4000*l.* spent on examiners, scholarships, exhibitions, and prizes, with practically nothing on salaries; grants for the teaching of drawing in schools of design; and grants to the Royal Dublin Society. The grants for schools of design had crept up year by year from 1300*l.* in 1838 to 14,755*l.* in 1850. The Royal Dublin Society received annually about 6000*l.*, sometimes a little more, sometimes less, and this was supposed to be expended very largely in the promotion of science and art.

In 1853 the new Department of Science and Art was launched, and the Geological Survey, the Geological Museum, and the Museum of Industry, Dublin, put under its charge. The infant South Kensington Museum and the well-established School of Design were also included, and the new organisation began its task of encouraging science instruction. But whatever may have been the views of far-sighted men like Sir Henry Cole, who then, as Mr. Cole, was making history as director, those in actual control were singularly blind to the future. Thus the Board of Trade in a letter to the Treasury in March, 1853, state that "in the proposed Department of Science and Art the motive power will be local and voluntary—the system in the main self-supporting."

In regard to the Geological Survey, it is stated:—"It is important to bear in mind that the expenses incurred on account of the Geological Survey are not permanent in their character, and will ultimately cease to be a charge upon the public." "Ultimately" is a good word, seeing that the expenses of the survey were in 1852–3 approximately 5500*l*., while sixty years later, in 1913–14, they were about 17,875*l*.

This short-sightedness was not confined to the Board of Trade, for the Treasury with due solemnity replied that in their opinion "the utility of (science and art) institutions is great in proportion as they are self-supporting."

If this test were applied to our existing science institutions there are few which could claim to be really of great utility.

Of more value was the statement made by the Board of Trade further on in the letter already mentioned that the "assistance received from Parliament will be applied tc the general good of all."

With these expressions of policy the Science and Art Department started on its career. The sums annually taken in the Estimate for its manifold activities gradually grew from year to year from 44,476*l*. in 1853–4 to 600,781*l*. in 1898–9. In the following year the amount granted is included in the Estimate for the Board of Education.

For many years the science grants were awarded on the results of examination and attendance. Before a school could claim payment for its work the students had to receive a certain minimum amount of instruction from a recognised teacher, this amount of instruction being spread over a certain number of weeks, so as to enable the instruction to be given systematically, with time for home-work and home-reading. Nothing was paid on account of those students who did not pass the examination at the end of the course, and the amount paid depended upon the grade of success, varying from a minimum of 1*l*. to a maximum of 5*l*. On the results of these examinations the National Scholarships, Royal Exhibitions, Whitworth Scholarships and Exhibitions, were also awarded and the examinations are still temporarily retained for this purpose.

It is of course easy to criticise this system but at the time it was instituted, examination was much more popular as a universal test of attainment than it is at present. At a time when children of tender years were being coached to pass an individual examination in reading, writing, and arithmetic not to mention a number of additional subjects, it was only natural that the same tests should be applied to the older students found in evening classes.

A centralised examination meant also the publication of official syllabuses for each of the branches of science in which examinations were held. These no doubt in time tended to cramp and stereotype the teaching but this ill effect was minimised by the fact that the examination papers always contained more questions than the candidate was permitted to answer and he was thereby enabled to select those parts of the subject which had formed the principal portion of his instruction or in which he was specially interested. It should also not be forgotten that in the case of the great majority of the candidates, certainly in the case of those above 16 years of age, the examination was looked forward to as a necessary crown to the session's work. With much that was feeble and almost worthless, and in spite of cramming and learning by rote, there was a substantial amount of good grain winnowed from the chaff and many a man can trace back his love of science or his success in life to what he learnt in science classes and to the rewards he gained through this much maligned examination system.

It must also be remembered that with few exceptions the examinations were in pure and not applied science, the underlying idea being to foster the study of the scientific principles on which our productive industries depend and to leave the practical working out of these principles to an enlightened self-interest. Nowadays applied science seems to have swept all before it and in the desire for quick results the need of a firm foundation of scientific principles is apt to be ignored.

The Science and Art Department stuck steadily for many years—perhaps too tenaciously—to the pure sciences and only extended its assistance generally to applied science when the system of payment on attendance and results gave way to the system of payment on attendance alone.

One of the early results of the change was distinctly beneficial. Under the examination system the only practical work in science for which grants were obtainable was in chemistry and metallurgy. When payment on attendance alone was established grants for practical work in physics were obtainable and physical laboratories began to be built and equipped. Especially was this the case in the day schools which had grown out of the science classes established in the elementary schools. In these schools—the organised science schools or schools of science as they were called—13 hours each week had to be devoted to mathematics, science, drawing, and manual instruction and the science had to include a definite proportion of laboratory work. The success of these schools so far as their rapid increase in number and in attendance was concerned was undoubted. Not only did the so-called higher grade elementary schools adopt the system but numbers of endowed secondary schools followed suit. For these latter the requirement of a definite amount of time per week for science and art work was often irksome and the close similarity of the curriculum in the higher grade and in the secondary school led to fears of competition and overlapping.

Inquiry showed that these fears were largely imaginary, but as at the time the State was developing its scheme of assistance to secondary education, the organised science school became officially unpopular and the discovery that school boards could not legally carry on such schools was the deathblow to systematised science teaching in connection with elementary day schools. The attempts to soften the blow by the establishment of higher elementary schools was unsuccessful in spite of much official pressure. The original minute under which these schools were to work was a marvel of restrictive officialism and though the stringency of the original regulations was subsequently relaxed the higher elementary school never prospered and nothing has yet effectively taken the place of the defunct organised science school. It remains to be seen whether the new junior technical schools, which after years of repression have forced their way into official recognition and favour, will fill the gap in the education of the elementary school boy or girl who, having gone through the ordinary elementary school course, has had neither the desire nor the opportunity to carry his training further in a secondary school.

Building Grants for Local Science Schools.

Aid was first granted towards the building of science schools in 1868, grants in favour of schools of art having been in existence since 1856. The rate of grant was half-a-crown per sq. ft. of floor space up to a maximum of 500*l*. The grant was withdrawn in 1897, but applications for aid received before that decision was published were accepted, and the claims so acknowledged were not finally liquidated until 1902. Thus, for a period of thirty-four years State aid was given towards the provision of suitable buildings for science instruction. It is of interest to see how this aid was appreciated. During the first half of the time 1868–1884 the grants paid amounted to 4,862*l.* 15*s.*, representing about 39,000 sq. ft. of floor space; during the second half of the term 1885–1902 the grants paid amounted to 43,183*l.* 15*s.*, representing 345,470 sq. ft. of floor space, or more than eight times as much as in the earlier period. In fact, before the edict went forth withdrawing this help the annual expenditure had crept up to nearly 4000*l.* a year, representing at least eight additional technical schools per annum. The remarkable increase during the latter half is due partly to the stimulus afforded to local authorities by the various Technical Instruction Acts, but public subscription provided no inconsiderable portion of the total, and it must be remembered that the State aid was only a small fraction of the total cost. It would be no exaggeration to say that this expenditure of public money of 48,000*l.* represented half a million of local funds devoted to building and equipping science and technical schools and institutes.

In addition to the aid given to science teaching by the payment made to teachers or to local committees on examination results, the science and art department promoted science instruction in a number of ways, which, without much expenditure of State funds, stimulated local interest and encouraged local expenditure for science purposes.

Among these minor influences the chief place must be given to the Royal Exhibitions and National and Local Scholarships, and with these should be coupled the Whitworth Scholarship and Exhibitions founded in 1867, which the department administered under Sir Joseph Whitworth's trust. These, fortunately—with the exception of the Local Scholarships—still continue, but it is doubtful if under present regulations they give the same opportunity to the working artisan as in the early days of their first establishment.

Grants towards the provision of laboratory fittings and toward the purchase of apparatus also served to encourage proper provision for experimental teaching at better total cost to the State. These also have disappeared, although it is still possible in certain circumstances to get aid toward the purchase of museum objects.

Prizes and medals were also in the early days found useful in encouraging students and incidentally in distributing among the successful competitors books which were of use in further prosecution of their science work.

These rewards, like the fittings, the apparatus, and the building grants, have now disappeared, and the amounts spent on them no longer appear separately in the estimates. It is doubtful, however, if the country has been saved the expenditure; like the recent savings resulting from the partial abolition of the May examinations, it may possibly reappear in the guise of an increase in the number of officials.

Science in Elementary Schools.

In the early years of State aid to elementary education no attention was paid to the claims of science beyond a pathetic desire that budding teachers should be encouraged to come forward for examination in land-surveying.

But with the rise of class subjects and the addition of "specific subjects" to the code in 1867, science teaching in elementary schools awoke. Special grants were made both for "class subjects" and for "specific subjects" on each child who passed the examination in the subject held annually by H.M. inspector. But very few inspectors either had much knowledge of or much love for science. Nearly all had been appointed for their literary or mathematical attainments, and it is not, therefore, surprising that the majority of the inspectors discouraged schools and teachers from taking science among the specific subjects. This was so generally evident that the British Association appointed a committee in 1879 specially to inquire into the matter. This committee was re-appointed with slightly varying functions from year to year until 1904, when it was reconstructed and the scope of its operations modified. Its annual reports contain statistics as to the various branches of science taken as specific subjects and as to the number of children taught, and it added from time to time some well-deserved criticisms on the general system.

In spite of general official discouragement, much admirable work was done, Liverpool and Birmingham being especially active in this respect. Those who had the opportunity of seeing some of the science teaching at these places can testify to the soundness with which it was given and to the genuine interest taken in it by the children.

By the year 1878–9 there were 29,459 children examined in physical geography, 20,506 in animal physiology, 1621 in mechanics, and 1332 in botany. Ten years later physical geography had disappeared, apparently having ceased to be a "specific subject" and become a "class subject" under the guise of elementary science. Animal physiology shows a falling off to 15,893 children examined, mechanics a big rise to 9651, botany a slight increase to 1944, while chemistry was taken by 1531 pupils, sound, light, and heat by 1076, magnetism and electricity by 1669, and principles of agriculture by 1199. We again pass on ten years, and find that in 1898–9 the numbers in animal physiology had grown to 41,244, in mechanics to 50,324, and in botany to 8833. Chemistry shows almost a tenfold increase to 14,737, magnetism and electricity had grown to 7697, sound, light, and heat to 1943, while principles of agriculture remains inactive at 1163. Various other branches of science also appear, with among them nearly 10,000 more. Science teaching in the elementary school seems to be flourishing, but a few years later the system of payment is altered; "specific subjects" disappear, and the teaching of science rapidly changes and then dies down.

The breaking down of the system by which the grants were made to depend upon class subjects and specific subjects, and the merging of these in the general course of the elementary-school curriculum, was no doubt educationally sound, but it certainly has had one effect: the reduction in the amount and the standard of science instruction; while the policy itself has not yet been effectually completed, since separate grants are still obtainable for "special subjects" such as handicraft, cookery, laundry-work, gardening, and dairywork.

There can be no doubt that there is less real systematic science teaching in our elementary schools than was the case twenty years ago, and that the proportion of the total expenditure on elementary education which can be looked upon as spent in promoting science instruction is decidedly less not only in proportion but in amount.

State Aid for Science in the Secondary Schools and the Universities.

State aid to secondary education grew out of the grants made to science classes. These classes were held at first only in the evening, but after a little some began to meet in the daytime. Some of the private schools and less well endowed grammar schools, attended partly by children of parents who might be described without much inaccuracy as belonging to the "industrial classes," began to realise that they might get help from the Science and Art Department. On its side the department promised an additional grant, first of 10*s*. and then of 1*l*. per head for pupils taking a definite course of science work, and passing successfully in at least one of the subjects of the course. Thus arose the organised science school. As has already been stated, most of the grammar schools found that the requirements of the department for an organised science school were too severe, and continued to get aid for separate science classes, and the organised science school scheme was for a time mainly worked either by schools of a more or less private character, by schools held in mechanics' institutes as at Leeds and Keighley, or by school boards. In fact, the organised science schools promoted and carried on by the bigger boards, as at Manchester, Salford, Bolton, Sheffield, and many other places, were so successful as to cause alarm to the grammar and endowed schools. A lively controversy arose in which the catchwords of overlapping and co-ordination made a frequent appearance.

By various modifications in the regulations, the purview of the Science and Art Department in the organised science schools was extended, first to requiring a certain amount of non-science work, secondly insisting on the teaching of at least one language other than English, and finally by requiring the whole of the secular portion of the curriculum to be submitted to inspection. This, with the alteration of the grant from one depending on results and attendance to one on attendance alone completed the process by which a large number of secondary schools found themselves in receipt of State aid and open to State inspection.

But this change was no sooner complete than the insistence on science instruction, which was the basis of the early system, was relaxed, till in the present day, when a grant of 774,000*l*. is taken for aid to secondary schools, none of it can be said to be specifically devoted to science instruction, although science must, as a general rule, form part of the school course. It is not too much to say that the weight of official recognition has passed from the scientific to the literary side of the secondary school, and that the time and energy devoted to instruction and practical work in science have shown a remarkable decrease. So much for the secondary school. We now come to the universities and the university colleges. Here the State aid has taken a variety of forms. The grant to London University began in 1839 with a modest 5,050*l*. for the expenses of examiners in various branches of knowledge, among which science held a worthy place. Expenses of administration were from time to time brought within the scope of the vote.

After the year 1891–2 the special vote for the London University practically disappears from the estimates. There had always been considerable receipts paid into the Exchequer, so that the sums actually voted had long ceased to represent a clear grant from the State, and in the succeeding ten years only modest sums from 100*l*. downwards are entered under this vote. At the same time, gradually increasing sums were voted for distribution among the universities and university colleges and the constituent colleges of the London University received, and still receive, substantial sums in this way.

The universities and the university colleges have enjoyed State assistance in a number of ways. First and for long the most important of these aids was the annual grant administered by the Treasury, and applied to what was considered by the Treasury advisers the proper work of universities—literature, mathematics, and pure science, excluding rigidly any applied science or technology, if such there chanced to be within the sacred precincts. This aid began in 1883–4 with a modest grant of 4000*l*. for the University College of Wales. It was increased to 8000*l*. in 1884–5, to 11,500*l*. in 1885–6, to 12,000*l*. in 1886–7, and to 14,000*l*. in 1887–8 and 1888–9. In the following year England begins to participate in the grant under this vote, and its subsequent fortunes are as follows:—

	£		£		£
1889–90	44,785	1898–99	104,507	1907– 8	201,400
1890–91	71,000	1899–1900	105,700	1908– 9	221,800
1891–92	71,000	1900–1	105,500	1909–10	217,400
1892–93	71,000	1901–2	116,700	1910–11	218,100
1893–94	83,000	1902–3	121,706	1911–12	303,800
1894–95	86,098	1903–4	119,100	1912–13	314,200
1895–96	98,339	1904–5	151,200	1913–14	314,300
1896–97	102,179	1905–6	197,300		
1897–98	104,059	1906–7	200,400		

A portion of this vote, about 28,000*l*., is, however, specifically voted for the purpose of Welsh intermediate education, and should, in fact, not appear here but in the vote for secondary education.

In addition, the universities and university colleges have received considerable benefit from the grants paid for the training of elementary-school teachers in the day training colleges.

Some instruction in science has always been a necessary portion of the training course, though it it must be admitted that the emphasis laid upon it in the day training colleges was always less than in the better residential colleges, and has in recent years evolved or degenerated (according to the views taken of its importance as a branch of training) into nature study or general experimental science. The principal value of this variety of State aid has been, not in any stimulus given to science instruction, but in the support it afforded in the early years of these colleges and universities to their arts side, a side which, without these day training students, would often have been non-existent.

The earliest mention of the State solicitude for the training in science of the future teachers in State-aided schools appears, as already stated, in the directions to inspectors in 1845 that inquiries should be made as to the attainments of the teacher in land surveying—an attempt presumably to give a rural bias to elementary education—the rural bias which, after seventy years, we are still seeking to impart. A more serious attempt was made in the newly-founded training colleges of St. Mark's, Chelsea, St. John's, Battersea, and Chester, where from the first some one or more subject of science—and we may also add—of handicraft, were included in the training course, and we may be certain that the inspector who reported on these colleges—Canon Moseley—was not unsympathetic to this infant attempt at a real general education.

Science teaching continued to flourish at the training colleges for many years. Laboratories were gradually built and fitted up, systematic practical work undertaken, and in the more powerful and well-equipped colleges an increasing proportion of their students were enabled to obtain the B.Sc. degree or the Inter B.Sc. of the University of London. Then came a period of official repression, when rightly or wrongly the attempt was made to devote the training college time more exclusively to the professional side of the schoolmaster's calling, and to discourage the working for degrees.

The growth of the day training colleges and their intimate connection with the universities has, however, rendered of slight effect the attempt to divert students from the degree studies, and the present tendency seems to be rather to encourage this university training by the grant of facilities for lengthening the training college course beyond its normal two years' duration.

The universities and university colleges had a third source of income from the State, although a very small and variable one, in the fees paid by the Science and Art Department for the attendance of teachers at science courses, and in the aid given toward the establishment of local exhibitions tenable at the colleges. Though the amount of the aid has been trifling so far as the actual sums are concerned, the effects have been remarkably good. Many a man now holding a good position in the scientific or industrial world can trace his success to the opportunities given him by these local exhibitions to pursue a course of systematic study in a fairly well-equipped institution of university rank. This is still more true of the Whitworth scholarships and exhibitions which were at one time generally held at an institution of this type.

But the most elastic source of Government aid to science work in the university was tapped for the first time when it was made clear to the university authorities that the Regulations of the Technical Branch of the Board of Education definitely offered assistance to "any institution in which systematic instruction in science or science and art was given." It only remained for the university to place, under the supervision of the Board of Education, the work in the applied sciences which the Treasury officers declined to recognise. After the first plunge was made one after another succumbed to the fascinating bait, and now all the universities in the country receive aid from the Board of Education for at least some portion of their work. The fears at first naturally felt that the acceptance of the Board's aid would result in fettering the teaching or the administration have so far proved in practice to be unfounded.

Following the example of the universities came the medical schools attached to the London hospitals, and the same elastic regulations enabled them, too, to be admitted to their share in the sums available for technical instruction. The first grant under this head was one of 1,000*l.* to St. Mary's Hospital Medical School in the year 1908–9. For the last financial year for which figures are available, a sum of 15,600*l.* was distributed among eleven medical schools—a very substantial and acceptable increase—while the total grant, including the universities and the university colleges, was 44,600*l.*—a sum, be it remembered, in addition to the Treasury grant.

It will therefore be seen that State aid towards science teaching of university standard has shown a distinct upward tendency, but a tendency more marked in regard to applied science, less obvious in regard to pure science.

State Aid for Agricultural Education.

State aid towards agricultural education began in 1888–9 with a grant of 5,000*l.* to the Agricultural Department of the Privy Council, and in 1890–1 the Board of Agriculture came into being. In the year following the creation of the new Department the amount voted had grown to 8,000*l.* It remained at this figure till 1895–6 when 1700*l.* was transferred to the Scottish Education Department.

By 1897–8 the expenditure had risen again to 7200*l.* In 1901–2 it was 8900*l.*, and ten years later had grown still further to 19,500*l.* In this year the Board of Agriculture captured the president of the Board of Education, and shortly after completed its triumph by annexing almost all the agricultural instruction formerly aided by the Board of Education and 6000*l.* of its grant. The Board of Education still controls and aids the pleasing and harmless fad of school gardens in connection with elementary schools and with evening schools for youths not over sixteen years of age. Thus, one whole branch and that not the least in importance has been definitely removed from the control of the State Department specially created to deal with education and put under another responsible for swine fever and cattle disease, ordnance survey, and the regulation of commons.

The change appears to have commended itself to the country and to the farming interest, for the grants for the present year are on a scale far in advance of anything before. The vote for agricultural education is 98,250*l.*, for forestry education 1000*l.*, for general agricultural research 43,815*l.*, for forestry research 1200*l.*, and for animal and plant pathology 18,650*l.*, making a total grant of 163,000*l.*, as against one of 78,000*l.* for the preceding year. But this is not all the State aid to agriculture. Scotland gets 51,184*l.* and Ireland 49,750*l.* In addition, there is a grant of just over 7000*l.* for fishery investigations. The obvious moral of these figures seems to be that technical instruction and research develop rapidly when confided to the care of an authority specially entrusted with this duty, instead of to one immersed in other and more immediately popular types of education.

State Aid for Scientific Research and to Learned Societies.

Finally we come to the aid given by the State towards scientific research. The total amount of the aid is, however, uncertain, and it is easy to omit items in various votes which might conceivably be properly classified under this heading. For our purpose the most important portions of this aid are (1) the research grant administered by the Royal Society. This began in 1850 with a sum of 1000*l.* and continued, in spite of some alarms of a possible withdrawal, till 1876, when an additional grant of 4000*l.* for five years was made. In 1882 the original grant of 1000*l.* and the additional grant of 4000*l.* were replaced by a single sum of 4000*l.*; and it has remained at that sum to the present time. An application for an increase was made in 1894, but not granted, but, possibly as a compromise, a grant of 1000*l.* was made towards the expense of the publication of scientific researches, and this grant still continues to appear annually in the estimates.

State aid to the various scientific societies of the country may be best dated from the year 1854–5, when a grant of 500*l.* was made to the Royal Geographical Society, and the grant has continued at the same amount. As already stated, the Royal Society grant of 1000*l.* was in 1856–7 definitely inserted in the Annual Estimates, but similar amounts had in fact been granted since 1851, the amounts for the succeeding years to 1855 being looked upon as special and not necessarily annual. In 1866–7 the Royal Society of Edinburgh secured 300*l.*, and in 1869–70 these three votes, with the grants for scientific investigations, were classified together as Votes for Learned Societies with a total of 12,300*l.* The subsequent history of this Vote is shown in the following table:—

	£			£			£
1870–71	12,370	...	1885–86	21,400	...	1900–01	50,724
1871–72	12,450	...	1886–87	24,400	...	1901–02	53,154
1872–73	12,450	...	1887–88	23,900	...	1902–03	68,396
1873–74	12,450	...	1888–89	21,900	...	1903–04	90,780
1874–75	13,300	...	1889–90	27,603	...	1904–05	46,407
1875–76	12,550	...	1890–91	25,253	...	1905–06	53,900
1876–77	12,550	...	1891–92	25,790	...	1906–07	57,650
1877–78	15,550	...	1892–93	25,896	...	1907–08	54,479
1878–79	17,050	...	1893–94	26,163	...	1908–09	56,295
1879–80	17,050	...	1894–95	26,247	...	1909–10	57,964
1880–81	17,050	...	1895–96	26,827	...	1910–11	74,228
1881–82	21,600	...	1896–97	28,154	...	1911–12	61,603
1882–83	20,900	...	1897–98	27,984	...	1912–13	125,523
1883–84	23,650	...	1898–99	28,452	...	1913–14	99,708
1884–85	23,400	...	1899–00	36,724			

On the whole, this may be looked upon as evidence that there is a recognised body of feeling in favour of annual subsidies of this character. The large fluctuations in the amounts are due to the initiation or the completion of the principal expenditure on various new branches of work, *e.g.* the National Library of Wales, the Antarctic Expedition, the Sub-Wealden Exploration, the North Wales University College, and so on. The vote is in fact the collection of miscellaneous items of expenditure, all of which may be said to be in some degree scientific in character, and which are, therefore, appropriately grouped under Class IV., Education, Science, and Art.

It has not been found possible to trace the grants specially allotted to Scotland and Ireland with any approach to accuracy. In the earlier years they were included in those for England and Wales. First one and then another item was removed and committed to the control of a department of the nation concerned. In this way the vote for Scottish Education appeared separately for the first time in 1875–6, and that for the Irish Department of Agriculture and Technical Instruction in 1899.

For the current financial year 1914–15, the votes for Scientific Investigation, etc.—the Societies being presumably the etc.—is apportioned as follows:—

	£
1. Royal Society Scientific Investigations...	4,000
Royal Society Scientific Publication ...	1,000
Royal Society Magnetic Observatory, Eskdalemuir	1,000
Royal Society National Physical Laboratory	7,000
Royal Society National Physical Laboratory, Aeronautical Section ...	12,550
2. Royal Society, Edinburgh	600
3. Meteorological Office	20,000
4. Scottish Meteorological Society	100
5. Royal Geographical Society	1,250
6. Royal Geographical Society of Scotland	200
7. Marine Biological Association	1,000
8. Royal Zoological Society, Ireland ...	500
9. International Geodetic Association ...	300
10. Solar Physics Observatory	3,000
11. North Sea Fisheries Investigation ...	1,250
12. British Antarctic Expedition	5,000
13. Edinburgh Observatory	1,637
14. International Seismic Association ...	210

Either the Scientific Investigation or the etc. also covers grants to the Royal Academy of Music, the Royal College of Music, Royal Irish Academy of Music, the Royal Irish Academy, the Royal Hibernian Academy, the British School at Athens and at Rome, the British Academy, and the National Library and National Museum of Wales. Among them they take 40,100*l.* of the total.

The conclusions to be drawn from these facts are simple and evident. The aid given by the State towards the advancement of science has increased in amount and variety so far as applied science is concerned. Questions dealing with matters of immediate utility connected with physics, biology, pathology, or agricultural practice have secured the attention of the State with a fair measure of success. But the support and encouragement formerly given to pure science have dwindled down till they are now almost lost among the grants given for the study of Shakespeare and tailors' cutting, the practice of cooking and Morris dancing, or the cultivation of languages from ancient Greek to modern Esperanto. All excellent objects, and all deserving of the nation's support, but in their rapid growth they bid fair to choke the tender plant of pure science, to the prior existence of which they owe their own flourishing condition, and the early struggles of which ensured their own success.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

London.—A course of six lectures on the international crisis in its ethical and psychological aspects will be given at Bedford College, Regent's Park, on Fridays, at 5.15, beginning on February 5. The lectures have been arranged by the council of Bedford College in co-operation with the Committee of Imperial Studies of the University of London, and are open to the public without charge. Viscount Haldane, visitor of the college, will be in the chair at the first lecture, when Mrs. Henry Sidgwick will speak on the morality of strife in its relation to the war. The other lecturers will be Prof. Gilbert Murray, Dr. A. C. Bradley, Dr. L. P. Jacks, Prof. Stout, and Dr. Bernard Bosanquet.

Several bequests for higher education are chronicled in the issue of *Science* for December 25 last. Mr. J. Arthur Beebe has bequeathed 30,000*l.* to the building club of the Harvard Club of Boston; 2000*l.* to the fund of the Harvard class of 1869, of which class he was a member, and 1000*l.* to Dr. F. C. Shattuck for investigations of tropical diseases. The residue of the estate, after some personal bequests have been paid, is bequeathed to Harvard University, the income to be used for the general purposes of the University. The University of Pennsylvania will be the ultimate beneficiary of the 40,000*l.* estate of the late Mr. William B. Irvine, ex-city treasurer, who died December 6. The money will provide either a building for a school of mining engineering or an auditorium.

During the second week of the year no fewer than twenty educational associations held meetings in London. The quality of the papers read was in many cases very high, and the attendances were such as fully to justify the organisers in their refusal to listen to those who suggested postponement on account of the war. The sense of national crisis deepened and strengthened the tone of the addresses whenever the subject under discussion was felt to concern national progress. It was the rule that the debates dealt with wide issues, and the fact that a drop in quality and interest affected the exceptional instances when minutiæ of the class-room or examination-hall fell to be discussed is perhaps scarcely a matter for regret. The problems of suitable science work to be undertaken in schools, including the aim of such work and its national influence, obviously rank among the matters which need statesmanlike handling in the near future. In her address to the Science Teachers' Association, Mrs. Bidder discussed the scientific training most suitable for girls, and urged that the work should be manual and scientific, so that girls could handle things and obtain a scientific attitude of mind. Elementary physical and chemical work should lead to appreciation of scientific method and scientific accuracy. Domestic work might be taught as an art or craft, and more things might be taught in the home—by which was not meant an increase in "home lessons." Girls could be taught to express themselves clearly through science lessons. The address was practical, and will no doubt be helpful to the science mistresses who heard it. It is a matter for great regret that no other paper on science teaching in schools (above the stage of nature-study) appeared at the conferences during Education Week, 1915. The presidential address delivered by Sir George Greenhill before the Mathematical Association upon the subject of mathematics in artillery science, did, however, deal largely with the unsatisfactory position which science occupies in the training of artillery officers.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, December 18, 1914.—Dr. A. Russell, vice-president, in the chair.—H. R. **Nettleton**: A vacuum guard-ring and its application to the determination of the thermal conductivity of mercury. A specially constructed vacuum vessel heated at the top by steam and cooled at the bottom by flowing water, is used to find the thermal conductivity of mercury. The vacuum acts as a guard-ring, which is at the same time not open to the well-known objection of communicating to the calorimeter a quantity of heat difficult to estimate. So efficient is the vacuum that the temperature gradient, as measured by a single thermo-junction carried by a cathetometer, is probably not in error to the extent of 1 part in 500. The mean value obtained for the thermal conductivity of mercury in a set of twenty-four experiments is 0·01960 c.g.s. units over the range 35° C. to 45° C. The remarkable linear nature of the temperature gradient obtained within the vessel, the cross-section of which was very uniform over the larger range of temperature, 35° C. to 65° C., would indicate at least that there is no diminution of thermal conductivity with rise of temperature.

BOOKS RECEIVED.

A Text-Book of Practical Assaying. By Prof. J. Park. Revised and enlarged edition. Pp. xii+342. (London: C. Griffin and Co., Ltd.) 7*s.* 6*d.* net.

Practical Field Botany. By A. R. Horwood. Pp. xv+193. (London: C. Griffin and Co., Ltd.) 5*s.* net.

A First Book of Commercial Geography. By T. Alford Smith. Pp. viii+151. (London: Macmillan and Co., Ltd.) 1*s.* 6*d.*

Calculus Made Easy. By F. R. S. Second edition. Pp. xi+265. (London: Macmillan and Co., Ltd.) 2*s.* net.

What Do We Mean by Education? By Prof. J. Welton. Pp. xii+257. (London: Macmillan and Co., Ltd.) 5*s.* net.

Fundamental Sources of Efficiency. By Dr. F. Durell. Pp. 308. (Philadelphia and London: J. B. Lippincott Co.) 10*s.* 6*d.* net.

Logic: Deductive and Inductive. By C. Read. Fourth edition. Pp. xvi+417. (London: A. Moring, Ltd.) 6*s.*

Directions for a Practical Course in Chemical Physiology. By Dr. W. Cramer. Second edition. Pp. viii+102. (London: Longmans and Co.) 3*s.* net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 14.

INSTITUTION OF ELECTRICAL ENGINEERS at 8.—The Shape of the Pressure Wave in Electrical Machinery: Dr. S. P. Smith and R. S. H. Boulding.

MATHEMATICAL SOCIETY, at 5.30.

MONDAY, JANUARY 18.

ROYAL SOCIETY OF ARTS, at 8.—Oils, their Production and Manufacture: Dr. F. Mollwo Perkin.

VICTORIA INSTITUTE, at 4.30.—Modernism and Traditional Christianity: Rev. Canon E. McClure.

TUESDAY, JANUARY 19.

ROYAL INSTITUTION, at 3.—Muscle in the Service of Nerve: Prof. C. S. Sherrington.

ROYAL STATISTICAL SOCIETY, at 5.

ILLUMINATING ENGINEERING SOCIETY, at 8.—*Discussion*: Some Points in Connection with the Scientific Development and Practical Applications of Searchlights.

WEDNESDAY, JANUARY 20.

ROYAL SOCIETY OF ARTS, at 8.—The Textile Industries of Great Britain and Germany: J. A. Hunter.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Annual General Meeting. Followed by an Account of the Proposed Climatological Atlas of the British Isles.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Notes on the History of the Microscope: Dr. C. Ginger.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.

GEOLOGICAL SOCIETY, at 8.—The Geology of the District around Machynlleth and the Llyfnant Valley: O. T. Jones and W. J. Pugh.—The Geology of the District between Abereiddy and Abercastle (Pembrokeshire): A. H. Cox.

THURSDAY, JANUARY 21.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Atmospheric Electricity Potential Gradient at Kew Observatory, 1898–1912: Dr. C. Chree.—Electromagnetic Waves in a Perfectly Conducting Tube: L. Silberstein.—An Electrically-heated Full Radiator: H. B. Keene.—The Transmission of Electric Waves over the Surfaces of the Earth: Prof. A. E. H. Love.

ROYAL INSTITUTION, at 3.—Modern Theories and Methods in Medicine: H. G. Plimmer.

ROYAL SOCIETY OF ARTS, at 4.30.—Nepal: H. J. Elwes.

LINNEAN SOCIETY, at 5.—Report on the Fishes Collected by Mr. Cyril Crossland in the Sudan: Miss Ruth C. Bamber.—Narrative of his Recent Visit to the Houtman Abrolhos Archipelago, West Australia: Prof. W. J. Dakin.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, JANUARY 22.

ROYAL INSTITUTION, at 9.—Problems of Hydrogen and the Rare Gases: Sir J. Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.

PHYSICAL SOCIETY, at 5.—Practical Harmonic Analysis: Dr. A. Russell.—Measuring the Focal Length of a Photographic Lens: T. Smith.

SATURDAY, JANUARY 23.

ROYAL INSTITUTION, at 3.—Aerial Navigation—Scientific Principles: Dr. R. T. Glazebrook.

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THURSDAY, JANUARY 21, 1915.

THE MANUFACTURE OF DYESTUFFS IN BRITAIN.

A SUMMARY AND AN APPEAL.

THE speech of Lord Moulton in Manchester on December 8, 1914, was a notable event, even in these days of strenuousness and surprise. For although he was careful to disclaim any official sanction of the views he expressed, it was common knowledge that the Government had requisitioned his services in investigating the question of the shortage of dyestuffs, and had based its policy largely on the advice he gave as the outcome of his investigation.

The general outline of the crucial position in which the British textile trades are placed at the present time is well known. At least 1,500,000 operatives are engaged in the various branches of the trade, which has an annual value of 200,000,000*l.* Nearly the whole of this vast industry depends for its commercial success upon the use of dyestuffs, which cost about 2,000,000*l.* per annum, and only about 10 per cent. of the necessary quantity of dyestuff is made in this country. Before the war, between 80 and 90 per cent. of our dye-wares was imported from Germany, and this supply is now entirely cut off. Unless, therefore, immediate steps are taken greatly to increase our national output and the supply from neutral countries (chiefly Switzerland), a catastrophe will very quickly overtake the great textile and associated industries.

The magnitude, gravity, and imminence of the crisis clearly pointed to the necessity for Government action, and a "Chemical Supplies Committee" was appointed to confer with the Board of Trade on the position. This committee included a number of well-known chemists, and manufacturers and users of chemicals and dyestuffs. The investigations of Lord Moulton and of this committee are understood to have formed the basis from which the offer of the Government was developed, but the committee was apparently not responsible for the details of the scheme for the establishment of a large Joint-Stock Dye Manufacturing Company, which was made public on December 22, 1914.

Prior to this, on December 10, 1914, a meeting of large users of dyes was held at the Board of Trade, at which a resolution was unanimously passed welcoming the assistance of the Government in a national effort to increase the British supply of dyes. A small committee, representative only of the users of dyes, was appointed, and elaborated the scheme to which reference has already been made for the formation of a manufacturing company.

An influential committee, appointed by the Society of Dyers and Colourists, has also made exhaustive inquiries on the technical side and has accumulated much valuable information.

It is well known that the difficulties involved in establishing on a permanent basis the manufacture of dyes on a scale adequate to supply our needs are enormous, and that without Government or legislative assistance they might well prove insurmountable; and the action of the Government in proffering such broad-minded and generous support has received, as it deserved, the recognition of all parties.

The German colour industry is probably the most complicated, most highly developed, and most profitable of all her great industries. The capital invested in it is about 12,000,000*l.*, and the German exports of dyes and associated products in 1912 were valued at 10,600,000*l.* The organisation, both for production and for marketing and distribution, is wonderfully efficient, and above all the Germans have long realised that in this branch of industry the scientific mind and scientific method must be predominant, not only in the laboratory and in the works, but in the management. The boards of directors of their large works are virtually committees of technical and commercial experts who are in intimate touch with the respective branches of the works of which they have special knowledge. In a word, the trained man of science has in these works come to his own, and a proper recognition of the necessity of this is vital to the development of the British colour industry.

The reasons for the predominance of Germany in this particular industry have been frequently and variously stated, but it is now generally conceded that there is no lack of highly-trained chemists in this country competent to build up a commercially successful enterprise. With regard to other factors, we have, of course, a superabundance of the coal-tar products which form the basis of the manufacture, but the manufacture of certain essential reagents, *e.g.*, fuming sulphuric acid, though already existing, may have to be increased.

Government assistance will be required in regard to the provision of cheap alcohol, and the resources and skill of the chemical engineer will be heavily drawn upon to provide the essential apparatus. A great number of chemists will be needed to work out the details of known processes, first on the laboratory scale, and later on a bulk basis, and the well-equipped laboratories and staffs of the universities and larger technical institutions might well be pressed into service for much of the preliminary work. Many chemists will also be required for developing new processes and other research work, because of no other industry can it be so truly said that stagnation spells failure.

The great complexity of the manufacture of dyestuffs is not due to the use of a large number of raw materials, the direct products from coal tar being only nine or ten. By chemical treatment these are, however, transformed into 250 to 300 different intermediate products which, in their turn, yield some 1200 chemically distinct dyestuffs. In some processes of manufacture high temperatures and pressures are required; in others the temperature must be reduced, and a large refrigerating plant is an essential feature of a colour works.

Surely, then, it is abundantly evident that the technical expert must be the preponderating element in the dye factory, and that he must have a large share in the management and control. The British custom of entrusting the management of large concerns to financiers, commercial magnates, and "men of affairs" has done much to retard the scientific development of our industries, and the adequate representation of the technical expert on the directorate is vital to the success of the new scheme.

Lord Moulton laid down three propositions with regard to the proposed new British dye manufacturing company. It must be large enough to be able to face severe competition at the end of the war. It must be, and must remain, entirely British, and, it must be co-operative; and all these conditions are fulfilled by the scheme put forward. It is proposed that the share capital shall be 3,000,000*l.*, and the Government offers to supplement this by a loan of 1,500,000*l.* at 4 per cent. and repayable in twenty-five years. The four and a half millions of capital thus proposed is probably ample to establish and develop an industry which would make us independent of imported products.

The proposals with regard to co-operation are that dyers and others associated with the consumption of the products, *e.g.*, spinners, manufacturers, merchants, textile machinists, etc., should take shares in the new company and thus become interested in its success. This is quite sound and receives general acceptance, but certain suggestions in the prospectus with regard to a *pro rata* subscription appear to be unworkable.

The Government reserves the right of appointing two directors of the company, and it is much to be regretted that the opportunity has not been taken of giving a wise lead in regard to the character of the directorate, by stipulating that the scientific technologist should be adequately represented.

Another feature of the scheme propounded by the committee is that certain existing colour works are to be taken over by the new company to form the nucleus of development. The resources of these works are to be extended as rapidly as possible in order to cope with immediate necessities and prevent an actual famine in dye-wares—in fact, large extensions are at the present moment being made.

A point which presents some difficulty in adjustment is the relationship of the new company to existing British dye-producing firms, or such as may be established in the future. It is obviously not desirable to stifle private enterprise by anything in the nature of a monopoly supported by the Government, but the existence of successful German firms which are outside the two great "Interessengemeinschäfte," or rings, indicates that the difficulty is more apparent than real. A somewhat cognate matter is the future relationship of the new company to the Swiss firms which are importing to us during the present crisis.

The various criticisms of the Government scheme which have been offered, refer, not to general principles, but in almost all cases to more or less important details. The general outlines of the scheme—the establishment by co-operation of those specially concerned, of a new company with great resources and financially aided by the Government—has received general approval, and the unprecedented step taken by the Government has been applauded by men of all parties, as meeting an industrial crisis in a bold and statesmanlike manner. In response to this, and in recognition of a national emergency, it is the obvious duty of all who are commercially interested, to deal with the question from the national rather than from the individual point of view. Support of a scheme for the manufacture in Britain of British used dyes is, at its lowest estimate, an essential business insurance, and on a higher plane it is helping forward a movement to free our great textile industry from the danger of German domination. Apart altogether from the commercial aspect, there is, therefore, a great obligation of patriotism involved. The scheme put forward—possibly as a *ballon d'essai* as regards details—certainly requires modification, but from it can be elaborated a national and co-operative effort which is bound to succeed.

Even to discuss the question of the breakdown of the proposal to make ourselves independent of German products, is almost a triumph for the enemies of our country, and a national humiliation for us. Let us all take as a starting-point of our deliberations that the thing *must be done,* and then the details of how to do it will fall into proper perspective.

Finally it may be pointed out that incidental advantages of enormous national value will accrue as the result of the successful fruition of this dye-ware manufacture scheme. The necessity for dealing with our industries from a national, rather than an individualistic, point of view will be more fully recognised by the Government and by the public. The necessity for the use of scientific method and control of our industries will be strongly emphasised. The claims of patriotism and the value of co-operation in commercial matters will receive fuller consideration, and lastly, the establishment of a powerful company for the manufacture of organic dyestuffs will afford protection to our great industries concerned in the manufacture of inorganic chemicals, an attack on which was beginning to be organised.

Now is our opportunity, and everything is propitious. Patriotism and self-interest are alike clamouring for the establishment of a large dye manufacturing concern, and the Government offers its support. One essential thing may, however, be overlooked—the new company is foredoomed to failure unless a scientific, rather than a purely commercial spirit permeates the management, and an appeal is made to the Government and to the eminent business men forming the committee who have issued the scheme that in its final form it may include a full recognition of this fundamental point.

WALTER M. GARDNER.

ELECTROMAGNETIC WAVES.

Electromagnetic Theory. By O. Heaviside. Vol. iii. Pp. ix + 519. (London: *The Electrician* Printing and Publishing Co., Ltd., n.d.) Price 21*s.* net.

IT is scarcely necessary to recommend to those interested in electromagnetic theory any book or article written by Dr. Oliver Heaviside. Since 1899 the scientific world has had in possession the first and second volumes of his "Electromagnetic Theory"; and these volumes hold a unique place in the literature of the subject. The first volume was reviewed in NATURE of 1894 (see vol. li., p. 171), and the second in 1899 (see vol. lx., p. 589). Now, after fourteen years of waiting, the world is enriched with the third and presumably the last volume containing the author's views upon the later developments of this ever-growing science.

The third volume is marked by all the characteristics of the earlier volumes. There is shown the same powerful grasp of the great principles of Maxwell's theory, the same intuitive intimacy with the hidden features of the electromagnetic field, the same boldness in materialising the mathematical conceptions, the same fearlessness in attacking really difficult problems, inventing new mathematics if necessary, or ingeniously turning to account old results got in different lines of inquiry. Every now and again he runs off into a side alley, at first sight quite away from the natural highway, but out of which he leads us back, with some substantial gain, fitting us the better for the strenuous work to come. And we need all our best powers to follow his lead. There is no shirking of difficulty; there is no yielding to authority. Every new fact or hypothesis in electromagnetism must pass through his critical mind, every new theory be looked at carefully and the evidences for and against balanced against each other. The book is indeed the product of a hard-working and ingenious mind, and bears throughout the unmistakable marks of the personality of the author.

The modified quaternion analysis which Dr. Heaviside introduced into the earlier volumes is used with good effect when occasion demands. There is, of course, nothing talismanic in the particular notation which Dr. Heaviside has adopted; and it seems a pity to stir up old controversy by reproducing letters written last century. When the author accuses Tait of viewing the same thing quite differently according as it is clothed in his (Tait's) favourite quaternion garb or in so-called vectorial vestments, he uses a sword with a cutting edge in the hilt. We have simply to change Tait to Heaviside and interchange the words quaternionic and vectorial, and the truth remains. And the curious thing is that all the change which Dr. Heaviside makes in the Hamiltonian notation is to drop the S for scalar and change the sign. Meanwhile more recent vector analysts equally despise Hamilton and Heaviside, and add to the confusion by inventing their own precious notations.

The subject-matter of the present volume is very simply described. It has to do with the generation and propagation of electromagnetic waves. There are two chapters which are numbered ix. and x. in continuation of the chapters of the earlier volumes. The sections are also numbered in continuation of the sections of vols. i. and ii. The fifty-three sections which constitute chapter ix. were published originally in the *Electrician* during 1900 and 1901, and are grouped under the title of "Waves from Moving Sources." Largely by synthetic methods the author constructs the solutions of various cases, discussing in his own way the fundamental question of the connection between matter and æther. Some interesting remarks are made concerning the investigations of Larmor and Lorentz. The later sections deal with spherical pulses started by a "jerked electron."

Chapter x. with its forty-one sections occupies about three-quarters of the whole book. It is called "Waves in Ether." The first seven sections, reprinted from the *Electrician* (1902) form a group of connected discussions in which a deformable æther is assumed along with a constant velocity of radiation through it. The assumptions are found to be compatible if the inductivity and permittivity of the æther vary as the density. The remaining sections, some of which appeared originally in NATURE, are more of the character of isolated articles, bearing either directly upon electromagnetic theory or upon mathematical and physical problems suggested by its development. For example, there is a long article on the solution of definite integrals by differential transformation, and one nearly as long on the inversion of operations. Still longer is section 534, on the theory of an electric charge in variable motion, probably one of the most important in the whole book. Here, as elsewhere, Dr. Heaviside strongly affirms the truth of Newton's Third Law of Motion, "an impregnable fundamental principle whose neglect sometimes leads to alarming consequences." Why, he asks at the very end of the volume, is this principle to be taken as fundamental? "Because it is always true when proper examination can be made, and is the guide to fresh knowledge. Besides that, the untruth of the principle in practice would lead to chaos."

Dr. Heaviside is also a firm believer in the existence of the æther. "Through this ether all known disturbances are conveyed electromagnetically or gravitationally. If the first way, the speed is finite. If the second way, it may also be finite, perhaps with the same velocity. . . . As the universe is boundless one way, towards the great, so it is equally boundless the other way, towards the small; and important events may arise from what is going on in the inside of atoms, and again, in the inside of electrons. There is no energetic difficulty. Large amounts of energy may be very condensed by reason of great forces at small distances. How the electrons are made has not yet been discovered. From the atom to the electron is a great step, but is not finality."

To the elucidation of the deep problems involved in this confession of scientific faith, Dr. Heaviside has made great and lasting contributions. The strenuously minded student will find him a stimulating guide through the intricacies of the electromagnetic equations. The book is with great fitness dedicated to the memory of George Francis Fitzgerald. C. G. K.

THE ASCENT OF SAP IN PLANTS.

Transpiration and the Ascent of Sap in Plants. (Macmillan's Science Monographs.) By Dr. Henry H. Dixon. Pp. viii+216. (London: Macmillan and Co., Ltd., 1914.) Price 5*s*. net.

PROF. DIXON first became known as an investigator of the problem of the ascent of water in plants by his work in collaboration with Dr. Joly published in the Proceedings of the Royal Society, 1894, and in the Philosophical Transactions, 1895, and from that time forward he has with admirable patience and efficiency continued to work at this difficult question. The appreciation of his position as an authority in this department is shown by his having been most appropriately chosen as a contributor to the "Progressus Rei Botanicæ," and finally as a writer in the present series of science monographs.

When a second edition is called for, it is to be hoped that Dr. Dixon will see his way to giving the references to literature as footnotes instead of at the end of the chapters, an arrangement that seems to us to have no practical advantages. The only other criticism of a general kind that we have to offer is on the relative space given to the two main divisions of the subject. There is but one chapter on the "nature of transpiration," while the remainder, consisting of about 200 pages, deals with the ascent of sap. But there is so much to be said on the latter subject that the author may well feel justified in his comparatively brief treatment of transpiration. There are many interesting points in chapter i., *e.g.*, the discussion on transpiration considered as a form of secretion, and the allied question of transpiration in air saturated with moistures.

Prof. Dixon does not, we think, quite realise the danger of assuming that the stomata are thrown out of action as far as transpiration is concerned by dull light or darkness. But inasmuch as his interesting experiments on transpiration in oxygen, air, CO_2, ether, and chloroform give values differing *inter se* in practically the same way as the evaporation of a surface of water under like conditions, it must be allowed that there is here no error of the above-mentioned kind.

The second chapter is devoted to the discussion of those hypotheses of the ascent of water in trees which depend on the co-operation of living cells in the water-way, views that may be said to begin with Godlewski's theory (1884), which was followed by the cognate hypotheses of Westermaier, Janse, and others. The whole chapter is good reading, but the most interesting part is the description of Dixon's experiments bearing on the effect of killing the sections of the water-way by heat. In this way it has been shown by Janse and Ursprung that the transpiration current is checked and that the leaves above the heated region wither. This fact was used as an argument for the "vital" theories of the ascent of water. But Dr. Dixon shows clearly that by heat, poisonous substances are developed, and that withering occurring above the injured region may undoubtedly be produced by this cause, and therefore that the argument for vital theories loses its validity.

With chapter iv. begins the kernel of the book, namely, the re-statement of the cohesion theory of the ascent of water. The most interesting features of this section are the discussions on the effect of air bubbles in the water conduits, and the evidence in favour of cohesion theory which is derived from a general discussion on the structure of wood.

This is followed in the next chapter by a discussion of the purely physical problem of cohesion. He confirms and extends Berthelot's estimation of the tensile strength of water containing air, a point of great value. He also works out the tensile strength of sap—a necessary precaution—and records the astonishing tensions of about 132 and 207 atmosphere. The sap used in these experiments was ingeniously obtained by centrifuging, a method likely to be useful in other botanical researches.

Having shown how great is the cohesion of the water columns, Dr. Dixon goes on to the other half of the problem—the resistance offered by wood to the passage of sap. He makes it probable that Ewart's estimate of this element in the problem is much too high, and points out (p. 132) "that if Ewart had obtained my results, the difficulty of resistance, which he finds to be fatal to the cohesion theory of the ascent of sap, would not have presented itself to him."

The rest of the book is mainly devoted to the question whether the leaves can develop traction sufficient for raising the sap, a force which he says (p. 139) "must at least be equal to the pressure produced at the base of a column of water which is twice the height of the transpiring tree." The problem in fact comes to be whether the osmotic pressure in the cells of the leaves is sufficiently great to account for the raising of water in very tall trees. One method employed was to expose leaves to compressed air in a closed vessel; in this way it was shown pressures of 26–38 atmospheres must exist in the leaves. Finally he proceeded to ascertain the osmotic pressure in the leaves by determining the freezing point of the cell sap. This was effected by employing a thermocouple in place of the thermometer used in Beckman's method of cryoscopy. In this way Dixon is able to determine the freezing point of small quantities of fluid—a practical point of considerable importance. The osmotic pressure in the leaves deduced by this method are finally shown to be more than sufficient to account for the ascent of water. F. D.

THE SCHUMANN REGION OF THE SPECTRUM.

The Spectroscopy of the Extreme Ultra-Violet. By Dr. T. Lyman. Monographs on Physics. Pp. v+135. (London: Longmans, Green and Co., 1914.) Price 5*s*. net.

THE remote ultra-violet part of the spectrum, first investigated by Victor Schumann and since known as the "Schumann region," has in recent years become of distinct importance in several directions. A knowledge of the vibrations of short wave-lengths is indispensable in the study of spectral series in relation to theories of emission spectra, and it has further been found that photo-electric, photo-chemical, and photo-abiotic processes become much more pronounced in this region. In the present monograph full accounts of the methods and results of observations are given in an interesting and convenient form by Prof. Lyman, who was among the first to take up and extend the work of Schumann. The first part of the book, referring to the ordinary ultra-violet spectrum included between wave-lengths 4000 and 2000, is a valuable introduction to the larger second part in which the Schumann region is dealt with.

As is now well known, the opacity of air, glass, and quartz to the Schumann rays renders it necessary that the entire spectrograph and source of light should be enclosed in a vacuum, and that special materials should be used for the construction of lenses and prisms; specially prepared photographic plates are also necessary. Schumann's apparatus was a "vacuum spectrograph" having prisms and lenses of fluorite, but Prof. Lyman has employed a concave grating of one metre radius, which is much simpler in adjustment and has the great advantage of permitting the determination of wave-lengths. A full description of this instrument is given, together with many practical details which have contributed to its successful manipulation. The absorption of various gases and materials in the region of short wave-lengths is fully discussed, and the spectra of the various elements which have hitherto been investigated are described in detail. Complete tables of these spectra, and a bibliography of the whole subject, are also included.

It is interesting to note that the author has lately succeeded in photographing the spectrum to wave-length 905, thus extending it as far beyond Schumann's limit as this was beyond the limit reached by Stokes, about wave-length 1850, if counted on the scale of oscillation-frequencies. Further extension by the direct spectroscopic method is beset by many difficulties, but the author does not consider it hopeless to make further attempts to reduce the gap between the shortest Schumann waves and the waves constituting X-rays, which have a wave-length of about one Ångström unit. In this gap the relation between "light" and matter undergoes a profound change, and further exploration would doubtless lead to results of great value.

The book is a valuable record of successful work in an important field of research, and will be indispensable to those wishing to undertake investigations in the Schumann region, or having occasion to make use of the available data of observation. It may, however, be confidently recommended to the larger circle of readers who are interested in the progress of physical science.

OUR BOOKSHELF.

The City of Dancing Dervishes and other Sketches and Studies from the Near East. By H. C. Lukach. Pp. xi+257. (London: Macmillan and Co., Ltd., 1914.) Price 7*s*. 6*d*. net.

THIS collection of papers, the work of a careful student of the Nearer East, most of which have already appeared in periodicals, is of value at the present time. The treatment, however, is sketchy, and some of the questions discussed do not easily lend themselves to popular writing. The chapter on the jests of the Turkish humorist, Khoja Nasr-ed Din, scarcely deserved re-publication, being a collection of "chestnuts," unless an attempt could have been made to trace their analogues in Western folklore. An interesting paper, based on personal knowledge, describes an interview with the Chelebi Effendi, the leader of the Dancing Dervishes, a Persian by origin, a scholar and theologian, intimately associated with the Turkish Court, his function being to gird each new Sultan with the historic sword of Osman at the Eyub mosque at Constantinople, a ceremony which no Christian is permitted to witness. The best result to be expected from the sketch of the Sunni and Shiah sects and of the origin and influence of the Caliphate may be to attract the reader to the standard authorities, from Gibbon to the Encyclopædia of Islam.

The net result of the book is to show the weakness of the Turkish Sultans' claim to the Caliphate, which will probably now be transferred to the new Sultan of Egypt, and to illustrate the hopelessness of the prospect of a Jehad or holy war preached from Constantinople. The Allies are quite aware of the weakness of the Turkish position, and one result of the war must be that Islam will be revolutionised, much to their advantage.

The Principles of Irrigation Practice. By Dr. J. A. Widtsoe. Pp. xxv+496. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 7*s*. 6*d*. net

As President of the Utah Agricultural College, Dr. Widtsoe has had almost unique opportunities of learning at first hand the results obtained by irrigation in the dry States of America, and in this book he gives a summary of his own investigations and those of others in neighbouring States. The general importance of the subject becomes manifest when it is realised that about 25 per cent. of the earth's surface receives ten inches or less of rainfall annually and can only be reclaimed by irrigation, while another 30 per cent. receives between ten and twenty inches of rainfall and requires irrigation for all intensive cultivation.

The first few chapters deal with theoretical considerations. The soil is likened to a mass of mineral particles, on which hangs a film of water; calculations are given to show its thickness, and some of its properties are sketched out This view is necessarily only approximately correct, because it is now known that the soil has not this simple constitution, but is essentially a colloidal mass. Many of the theoretical considerations founded on the older and simpler idea therefore require modification. Similar remarks also apply to some of the coefficients and constants applied to the soil moisture: their theoretical interest is not great, although they are very important as guides to the practical man in irrigation practice. The chapters, however, give as good a summary as our present knowledge permits, and they clearly show how necessary it is to overhaul the whole subject in the light of modern conceptions.

By far the greatest part of the book is taken up with an account of the effect of irrigation on the crop and on the land, and illustrations and diagrams are given in profusion. The work is admirably done, and gives one of the best summaries of the subject that we have seen for some time.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Electrical Notation.

THE variety of notations for electrical quantities has become a real difficulty in reading international literature. Up to the end of last century the notation of Maxwell was the standard in Great Britain, and such extensions as became necessary were grafted on it. There is no sign of its dying out among the workers, many of them of fundamental importance, who have been accustomed to employ it—in pure science at any rate.

You direct attention (p. 541) to the conflicting recommendations produced simultaneously by two committees, each carrying authority. As the list which you reproduce on p. 545 claims to have international force, it would be interesting to speculate how many readers could guess what are the quantities proposed to be denoted by the symbols η, f, G. ϵ, X, Z, S, Φ. A German equivalent for f is given as ν, which is usually synonymous with n further up in the table; so that f seems to be a duplicate.

Cambridge, January 15. J. LARMOR.

The Influence of Icebergs on the Temperature of the Sea.

THE part of the "Report on the work carried out by the s.s. *Scotia*, 1913," on the above subject, referred to in NATURE of January 14, will, I fear, be a great disappointment to many after the great promise given by the new line of investigation discovered by Prof. H. T. Barnes, of Montreal University. Prof. Barnes found, by means of a very sensitive registering thermometer, that there was always a rise in temperature of the sea on approaching icebergs, and part of the *Scotia's* work was to check this observation. The *Scotia* was fitted with two sensitive registering thermometers, one to be used for trawling near the surface; the other was placed in a box through which the condenser water for the engine was pumped. Unfortunately, both these instruments soon became defective owing to sea water leaking into them. The one used for surface temperatures was repaired on the voyage, but the other does not seem to have been restored to working condition. The result is that all the temperatures taken with the recording instrument are surface temperatures taken at a depth of 2 ft.

The following is the conclusion come to by the observers on the *Scotia*. "An inspection of the records . . . leads to the conclusion that the temperature of the sea near its surface does not furnish a certain method of detecting the presence of an iceberg in the regions over which the *Scotia* made her voyages." Now Prof. Barnes's conclusion was not arrived at from temperatures taken near the surface, but at some depth. His records of the rising temperature on approaching icebergs were made with his first ship, in which the thermometer was placed at a depth of 5 ft., but better results were obtained by his second ship, in which it was placed at a depth of 16 to 18 ft.

In justification of their conclusion that their surface temperatures ought to give results similar to the deeper ones, the observers on the *Scotia* seem to have accepted Prof. Barnes's explanation of the cause of the rise in temperature near the berg. Prof. Barnes says all the water from the melting ice is carried downwards, and that this downward current is supplied by a surface current flowing towards the berg, and that this surface current, in some way not explained, retains all the solar radiation, which he says usually penetrates deeper, but is, he says, prevented by the water being in motion. If that explanation be correct, then the *Scotia's* observers would be quite right in supposing that the rising temperature would be more manifest at the surface than at some depth. Though the *Scotia's* observers accepted Prof. Barnes's explanation of the heating of the water, they do not seem to be satisfied with it, as they say: "This explanation is difficult and seems complicated."

Prof. Barnes's explanation is founded on the supposition that all the water of the melted ice is carried downwards. Dr. Otto Pettersson, on the other hand, says that only the water of the ice melted some distance below the surface is carried downwards, while that melted near the surface flows away from the berg on the surface. In a previous letter (NATURE, January 9, 1913) I showed by two methods of experimenting that all the water of the melted ice comes to the surface. I think it is generally admitted that the salinity of the sea is, as a rule, lower in the vicinity of melting ice than at a distance from it. If so, where does the fresh water come from if not from the melted ice? Outside the rising current of diluted sea-water next the ice there is a descending radiation-cooled current of sea-water drawn from a distance and flowing underneath the ice-cooled water on the surface. This downward current is accepted by Prof. Barnes and Dr. Pettersson, though Prof. Barnes does not admit the existence of the cold-surface current. Accepting the existence of these currents in the water surrounding icebergs, the following explanation was offered in NATURE (March 16, 1913) of the rising temperature observed on approaching icebergs. The surface water at a distance from a berg has a higher temperature than the water immediately underneath it. That is, outside the influence of the berg the temperature decreases with the depth, so that when the surface water is submerged by the cold-surface current, it is sunk to some depth beneath the surface, the result of this being that a thermometer sunk to a depth of, say, 16 ft. when at a distance from the berg registers a lower temperature than if placed in the surface water; but if the deeply submerged thermometer be moved into the water near the berg, it will now register a higher temperature than it did at a distance from it, because it will now be in the submerged-surface water, the temperature of which will probably have fallen to some extent in its passage under the cold-surface water. The effect of the movement of the ship towards the berg is virtually the same as raising the thermometer towards the surface when the ship is outside the influence of the berg. In the letter referred to I suggested the use of two thermometers, one near the surface, the other at some depth, and registering together, when an inversion of the temperature would indicate the approach to ice, if the explanation be correct. If this inversion of temperature really does exist, it might be detected by the ordinary tilting thermometers, one in the water near the surface, and others at depths down to three or four fathoms, as the difference that might be looked for from Prof. Barnes's thermograms amounts at times to a degree or more Centigrade, an amount easily detected by means of thermometers of that kind.

It is a great misfortune that the thermometer in the condensation water of the *Scotia* could not be repaired for the investigation. The depth at which the inlet of the condensation water was placed is not stated in the report, but from the size of the vessel it could not be very deep, and the best results could scarcely be expected from it, and for the same reason it would be of no use save in fine weather, owing to the rolling of the vessel constantly changing the level from which the water was drawn. Still, under calm conditions, it might have been deep enough to touch in some cases Prof. Barnes's rising temperature.

Prof. Barnes's results are so consistent and definite that they carry conviction, and one can scarcely imagine that the observations taken when sailing towards, and from, an iceberg in many different directions, which enabled him to draw the isotherms all round the berg as given in his report and reproduced in your issue of December 12, 1912, could be the result of chance, and not of something which had a real physical existence. It is possible that the conditions there represented may be rare, as they seem to indicate that the berg and the water had travelled together for a long time. It seems probable that in many cases the distribution of the isotherms will not be so regular owing to the berg and the water moving at different rates and in different directions. One conclusion we may, however, come to from the *Scotia's* observations which is that the explanation of the rising temperature on approaching icebergs is not due to radiation as supposed, as the registering thermometer on the *Scotia,* though not as sensitive as that used by Prof. Barnes, was yet easily capable of detecting changes such as those indicated by Prof. Barnes's thermograms. It is to be hoped that the subject will be further investigated after the war is ended.

JOHN AITKEN.

Ardenlea, Falkirk, January 4.

The Longevity of Seeds.

IN the note in NATURE of January 7 (p. 515) upon Mr. Shull's paper in the *Plant World,* referring to the longevity of seeds, it is stated that this "is a subject on which specific information is always desirable." The following, therefore, may at least contribute suggestion.

In 1862, my father, at a cost of 4000*l.*, caused Dowalton Loch, the largest sheet of water in Wigtownshire, to be drained. The operation attracted considerable attention at the time, owing to the subsequent exploration of a number of "crannogs," or lake dwellings of the fascine type which were laid bare. The bottom of the lake, about 200 acres in extent, was for the most part covered with deep mud and peat; but across the centre of it lay a ridge of broken rock, now a dense jungle of dog willow (*Salix caprea*), whereof the seeds were no doubt wind blown.

Six years ago I was clambering among these rocks, and, coming upon an open space in the thicket, found to my surprise that the ground, to the extent of nearly an acre, was thickly covered among the stones with a carpet of *Pyrola minor.* Nowhere, except in Norway, have I seen this pretty plant in such profusion.

Now, although I have given fairly close scrutiny to the phanerogamous flora of this country, I have not found *P. minor* within its bounds, though for forty years I have known of a colony of it in the neighbouring county of Kirkcudbright, about five and twenty miles in a straight line from Dowalton Loch. *P. rotundifolia* also grows on the banks of the Cree about twenty miles distant.

No doubt *P. minor* once abounded in Wigtownshire, but it has disappeared under the plough, though it may linger still in the remote moorland. Dowalton Loch lies in the heart of an arable, closely cultivated district. Whence, then, did the minute seeds come which have produced this surprising crop? Have they lain dormant under the waters of the loch since the days of the lake-dwellers, or—a more moderate guess—since the days when the primeval forest bordering the lake was cleared away and the land broken up for tillage?

I shall be happy to receive a visit from anyone who may desire to verify for himself the topography of the district in connection with this isolated mass of Pyrola.

HERBERT MAXWELL.

Monreith, January 11.

S. T. Coleridge and the Immortality of the Protozoa.

THAT Weismann's aphorism regarding the "immortality" of the Protozoa had been uttered by others before him is not unknown; and Mr. Clifford Dobell in a recent paper ascribes to Ehrenberg the first expression of the idea. Ehrenberg's book was published in 1838; but Coleridge had said the same thing many years before in his "Biographia Literaria," published in 1817 and written a couple of years earlier. In a footnote to chap. iv. (on Wordsworth's "Lyrical Ballads") he says: "There is a sort of minim immortal among the *animalcula infusoria,* which has not naturally either birth or death, absolute beginning or absolute end: for at a certain period a small point appears on its back, which deepens and lengthens till the creature divides into two, and the same process re-commences in each of the halves now become integral." No statement of the case could well be plainer or more precise than this. I wonder whether Coleridge was indeed the first to make it; or whether some one of the eighteenth-century naturalists had already drawn the inference—not, after all, a very profound one—that a creature which multiplies by simple fission "has not naturally either birth or death," and may be called "immortal."

D'ARCY W. THOMPSON.

The Cause of Streaks upon Lath-and-Plaster Walls.

FOR some time past I have been observing the streaks which occur upon lath-and-plaster walls. I have made a survey of the literature and find no adequate treatment of the phenomenon. For that reason I take the liberty of submitting to you the results of my observations in the hope that you may find them worthy of publication. The results of my observations are as follows:—

(1) The striations are accumulations of dust upon the surface of the plaster. They may be wiped off with a cloth.

(2) The phenomenon occurs only on warmer surfaces of walls which are exposed on the other side to out-of-doors or to colder rooms.

(3) The steeper the temperature gradient through the wall, the more pronounced is the phenomenon.

(4) The light streaks, the spaces comparatively free from dust, occur over laths and joists, the dark streaks over the spaces between them.

Poynting and Thomson ("Text-book of Physics: Heat," p. 152) suggest "that the phenomenon is a probable illustration of 'radiometer action.'" The areas of plaster backed up by wood are probably warmer than those areas not so protected. From the supposedly warmer area an approaching dust particle is repelled by a more vigorous molecular bombardment than it encounters upon approaching the supposedly colder area.

I was led to inquire whether this explanation is a complete one upon observing what appears to be a related phenomenon. In a room rather free from dust but quite damp, the areas of plaster which ordinarily would be streaked with dust were quite clean, but were much discoloured by water. This observation raises the question as to whether condensed water vapour may not be the trap which catches the dust.

I contemplate carrying out a series of experiments to answer the following questions:—

(1) Under given conditions what difference of temperature exists between a plaster area backed up by lath, and an adjacent area not so protected?

(2) What part does the presence of water vapour in the air play in the phenomenon?

(3) Can a "reversal" of the phenomenon be produced? Thomas D. Cope.

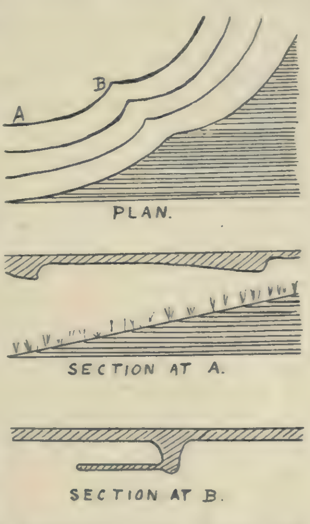
University of Pennsylvania, Philadephia,
December 18, 1914.

Curious Forms of Ice.

On December 30, 1914, when a heavy rainfall had been followed by a night frost, a layer of prismatic ice was seen immediately below the surface of the heaps of loose clay, in shallow workings in clay-with-flints at the south-west end of Walton Heath, Surrey. The workings are near the crest of the North Downs, at an elevation of about 600 ft. The ice varied from ½ to 1¼ in. in thickness, and resembled the form of calcite known as "beef," but even in the most compact portions the prisms were not in close contact with one another. When observed, about midday, the ice was melting, and the sides of some of the heaps were strewn with isolated prismatic and acicular crystals of ice.

This prismatic layer of ice is similar to the ice pillars described in Nature (vol. lxxiii., 1906, pp. 464, 485, and 534), and analogous to the masses of fibrous ice connected with lumps of chalk, recorded in Nature (vol. lxxxviii., 1912, pp. 484 and 517).

On the same occasion, shallow pools of rain-water on Walton Heath and Headley Heath were seen to be covered with thin ice, which showed a series of concentric markings parallel to the margin. These markings were formed by ridges on the lower surface of the ice, presenting an abrupt face toward the margin and a gentle slope toward deep water. The ice in the ridges contained air bubbles. The ridges were about 4 in. apart, and in some places as many as seven in number. At points where the direction of a ridge changed, as at B in the figure, a tongue of ice projected downward and sometimes supported horizontal rods of ice half an inch below the surface.



These projections may be analogous to the "bulb formation" referred to by writers in Nature (vol. lxxxviii., 1912, pp. 414 and 492, and vol. lxxxix., 1912, p. 34). The ridges differ in cross section and direction from those described in Nature (vol. xc., 1912, p. 411). The pools did not show signs of loss of water by percolation. At first sight I regarded the ridges as earlier shore lines, marking successive extensions of the pools as water flowed into them, but the parallelism and equal spacing of the ridges are perhaps against this view. They may possibly be due to ripples. G. M. Davies.

Birkbeck College, London, January 12.

The Fireball of December 31, 1914.

I am writing to tell you that I also observed the fine meteor described in Nature of January 7 (p. 517) as having been seen at Bexley Heath on December 31 at about 11.15 p.m. I saw it from my window, facing the west, and I cannot better your description of it as "a fireball, much brighter than Venus."

Its course was from north to south, rather low down, and the sky at the time was clear above, but misty below. The meteor disappeared without leaving a luminous track behind, and seemed to dip into the mist.

I did not notice what stars it passed near, as the moon was shining; possibly there were not many just then distinctly visible.

Frances M. Harvey.

15 Purland Chase, Ross, Herefordshire.

THE PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION.

The sixty-sixth meeting of the American Association for the Advancement of Science was held at Philadelphia, Pa, on December 28, 1914—January 2, or, as it is termed, during the Convocation Week, 1914–15, under the presidency of Dr. Charles W. Eliot, President Emeritus of Harvard University. The Section on Education of the A.A.A.S. is a comparatively new one, and this was the first meeting at which a member of this section has been president of the Association.

The meetings were, almost without exception, held in the commodious buildings of the University of Pennsylvania; the only exceptions being the meetings of Section E of the Geological Society of America and the Palæontological Society of America, which were held at the Academy of Natural Sciences in the central part of the city.

At the opening session, December 28, 1914, the meeting was opened by the retiring president, Prof. E. B. Wilson, of Columbia University, who introduced president-elect Eliot. Addresses of welcome were given by Dr. E. F. Smith, Provost of the University of Pennsylvania, by Dr. W. W. Keen, President of the American Philosophical Society, by Dr. S. G. Dixon, President of the Academy of Natural Sciences, and by Mr. J. M. Dodge, representing the Franklin Institute.

Dr. Eliot replied to these addresses, and the retiring president, Dr. Wilson, then delivered his address on the subject "Some Aspects of Progress in Modern Zoology," which is printed elsewhere in this issue of Nature.

After the adjournment of the meeting, the provost of the University and Mrs. Smith received the association and its affiliated societies in the University Museum.

The meeting was a very large one, possibly the largest in the history of the association. Registration figures indicate that there must have been more than two thousand scientific men and women in attendance. The number of affiliated societies meeting at the same time and place was also unusually large. It included the following societies:—

Society of American Bacteriologists, Entomological Society of America, American Association of Economic

Entomologists, Botanical Society of America, American Phytopathological Society, American Psychological Association, Society of American Zoologists, American Society of Naturalists, American Microscopical Society, American Physical Society, Geological Society of America, Palæontological Society of America, American Folk-Lore Society, American Fern Society, Sullivant Moss Society, American Nature-Study Society, School Garden Association of America, American Alpine Club, American Anthropological Association, Southern Society for Philosophy and Psychology, Society for Horticultural Science, American Federation of Teachers of the Mathematical and the Natural Sciences, Society of Sigma Xi.

The meeting as a whole emphasised more than ever the importance of symposia for broad topics which bring together men of different sections. A number of these were held during the week, as follows:—

Section B and the American Physical Society, on the subject, "On the Use of Dimensional Equations."

Botanical Society of America and the American Phytopathological Society, on the subject, "Genetic Relationship of Organisms."

Section of Agriculture, "The Field of Rural Economics."

Section F, the American Society of Zoologists, and the American Society of Naturalists, "The Value of Zoology to Humanity."

Society of American Bacteriologists and Section K, on the subject of ventilation.

Sections C and K and the Society of American Bacteriologists, on the subject, "The Life of Lower Organisms in Relation to Man's Welfare."

There were two especially notable incidents of the meeting. The first of these was the first large meeting of the newly-established Committee of One Hundred on Scientific Research, of which Prof. E. C. Pickering, of the Harvard College Observatory, is chairman, and Prof. J. McKeen Cattell, of Columbia University, the secretary. Reports were received from a number of sub-committees, other sub-committees were established, and the work of the committee as a whole was systematised in order to cover the whole field of scientific research in America with the view of the ultimate ascertaining of its needs. The listing and classification of research funds, the needs of research students, the co-ordination of research among educational institutions, private endowments and industrial research, and a number of other topics will be taken up by this committee.

The second notable event of the meeting was the first session of the newly-established Section of Agriculture (Section M). This opening meeting was presided over by the president of the association, Dr. Eliot. The vice-president, Dr. L. H. Bailey, formerly Director of the College of Agriculture of Cornell University, gave his address on the subject: "The Place of Research and of Publicity in the Forthcoming Country Life Development." The symposium which followed consisted of the following addresses: "Rural Economics from the Standpoint of the Farmer," by Hon. Carl Vrooman, Assistant Secretary of Agriculture; "Credit and Agriculture," by Prof. G. N. Lauman, of Cornell University; "Marketing and Distribution Problems," by C. J. Brand, Chief of the Office of Markets, U.S. Department of Agriculture; and "Distinction between Efficiency in Production and Efficiency in Bargaining," by Prof. T. N. Carver, of Harvard University.

The following addresses of the presidents of sections were delivered during the week:—

(*a*) F. Schlesinger, "The Object of Astronomical and Mathematical Research"; (*b*) A. D. Cole, "Recent Evidence for the Existence of the Nucleus Atom"; (*c*) C. S. Alsberg, "Theories of Fermentation"; (*d*) O. P. Hood, "Safety Engineering"; (*e*) J. S. Diller, "The Relief of Our Pacific Coast"; (*f*) A. G. Mayer, "The Research Work of the Tortugas Laboratory of the Carnegie Institution at Washington"; (*g*) H. C. Cowles, "The Economic Trend of Botany"; (*h*) W. B. Pillsbury, "The Function and Test of Definition and Method in Psychology"; (*i*) J. G. Wall, "Social and Economic Value of Technological Museums"; (*k*) T. Hough, "The Classification of Nervous Reactions"; (*l*) P. P. Claxton, "The American Rural School"; (*m*) L. H. Bailey, "A Place of Research and of Publicity in the Forthcoming Country Life Development."

Following the example of the British Association for the Advancement of Science, two public evening lectures complimentary to the citizens of Philadelphia and vicinity were given. Dr. D. C. Miller, of the Case School of Applied Science, lectured on Tuesday evening, December 29, on "The Science of Musical Sounds," illustrating his lecture by a large number of striking experiments. The second was given on Wednesday evening by By Dr. W. H. Nichols, of the General Chemical Company, on "The War and Chemical Industry." These lectures were rather largely attended, but the American Association has not as yet succeeded in making these lectures as important, viewed as social functions, as has the British Association.

No strikingly important matters of business were considered by the council. A few small research grants were made, and the assistance of the association was continued to the Concilium Bibliographicum Zoologicum of Zurich. It was decided to hold a summer meeting in 1915 at San Francisco under the auspices and management of the Pacific Coast Division of the American Association, the dates to be August 2 to 7. For the place of the next Convocation Week meeting (December 27, 1915, to January 1, 1916), Columbus, Ohio, was chosen. It will be remembered that the association had virtually accepted an invitation from the University and City of Toronto, Canada, for this last-named meeting, but on account of conditions arising from the war, Toronto begged to be allowed to postpone this meeting to some future and more favourable date.

At the close of the meeting the following officers were elected for the coming year:—

President: Prof. W. W. Campbell, Lick Observatory, University of California.

Presidents of Sections: A, *Mathematics and Astronomy*, Prof. A. O. Leuschner, University of California; B, *Physics*, Prof. Frederick Slate, University of California; C, *Chemistry*, Prof. W. McPherson, Ohio State University; D, *Engineering*, Mr. Bion J. Arnold, of Chicago; E, *Geology and Geography*, Prof.

C. S. Prosser, Ohio State University; F, *Zoology*, Prof. V. L. Kellogg, Stanford University; G, *Botany*, Prof. W. A. Setchell, University of California; H, *Anthropology and Psychology*, Prof. G. M. Stratton, University of California; I, *Social and Economic Science*, Dr. Geo. F. Kunz, of New York; K, *Physiology and Experimental Medicine*, Prof. F. P. Gay, University of California; L, *Education*, Prof. E. P. Cubberley, Stanford University; M, *Agriculture*, Prof. Eugene Davenport, University of Illinois.

Permanent Secretary: Dr. L. O. Howard, Smithsonian Institution, re-elected for a five-year period from August 20, 1915.

General Secretary: Dr. Henry Skinner, Academy of Natural Sciences, Philadelphia, Pa.

Secretary of the Council: Prof. W. E. Henderson, Ohio State University.

Secretaries of the Sections: A, Forest R. Moulton, University of Chicago, Chicago, Ill.; B, W. J. Humphreys, U.S. Weather Bureau, Washington, D.C.; C, J. Johnston Geophysical Laboratory, Carnegie Institution of Washington, Washington, D.C.; D, A. H. Blanchard, Columbia University, New York; E, G. F. Kay, State University of Iowa, Iowa City, Iowa; F, H. V. Neal, Tufts College, Mass; G, W. J. V. Osterhout, Harvard University, Cambridge, Mass.; H, G. G. MacCurdy, Yale University, New Haven, Conn.; I, S. C. Loomis, 69 Church Street, New Haven Conn.; K, C. E. A. Winslow; L, S. A. Courtis, Liggett School, Detroit, Mich.; M, E. W. Allen, Office of Experiment Stations U.S. Department of Agriculture, Washington, D.C.

Treasurer: R. S. Woodward, Carnegie Institution of Washington, Washington, D.C.

Assistant Secretary: F. S. Hazard, Office of the A.A.A.S., Smithsonian Institution, Washington, D.C.

THE EARTHQUAKE IN CENTRAL ITALY.

THE earthquake of January 13 was by no means one of the first order of magnitude, but it was the most destructive of which we possess any record. In Avezzano, which formerly contained 11,000 inhabitants, the death-rate amounts to 90 per cent., while it rises still higher in some of the adjoining villages, in Cese to 94 per cent., and in Lapelle to 97 per cent. Before this, the highest known death-rate was 81 per cent. at Avendita during the Norcian earthquake of 1703. There can be little doubt that the disastrous character of this earthquake was as usual due to the faulty construction of the houses, which consisted of stones with little or no binding of cement. Partly, also, it was due to the comparative immunity of the central district from great earthquakes in the past, which has allowed such buildings to survive.

Few details of scientific value have as yet reached this country. The earthquake occurred at 7.53 a.m. (or 6.53, Greenwich mean time). At Rome, it lasted from 15 to 20 seconds. Near the epicentre, there was one shock of great violence, followed by three others. In other neighbouring places, two prolonged shocks were felt. The principal epicentre was no doubt close to Avezzano, probably within five miles of that town. It was in this district that the high death-rates occurred. There was apparently, however, a secondary epicentre including Sora, where 500 persons lost their lives, and Isola Liri; and it is possible that the double shock noticed at some places was due to impulses in two corresponding foci, about twenty or twenty-five miles apart. The area of perceptible damage to buildings extends almost across the peninsula, from Rome on the west to Chieti on the east, these places being 110 miles apart. Towards the north, the shock was felt at Ancona, Perugia, and Grosseto, and, towards the south, at Naples and Potenza; that is, over an area roughly 300 miles long, 240 miles wide, and containing about 56,000 square miles. The shock was recorded at many distant observatories, including those in this country and at Washington. The after-shocks must have been very numerous in the epicentral area. More than 120 were registered at Rome during the first two days, all of them slight, with the exception of one at 8.14 a.m. on January 14.

Earthquakes are neither frequent nor severe in the district chiefly affected. Dr. Baratta, in his "I terremoti d'Italia," defines in it two distinct seismic zones, one including Sora and Isola Liri, the other, less important in the past, extending from Avezzano to Anticoli. To the former zone belong the strong earthquakes of August 19, 1777, and May 9, 1891; and, to the latter, the earthquake of April 10, 1885. The recent shock must have been far stronger than any of these earthquakes, and, as pointed out above, it seems to have consisted of almost simultaneous impulses in both the Avezzano and Sora centres.

C. DAVISON.

VICE-ADMIRAL SIR GEORGE NARES, K.C.B., F.R.S.

BORN at Aberdeen in 1831, G. S. Nares entered the Navy on board H.M.S. *Canopus*, an old battleship captured from the French, in 1845, and was transferred to the *Havannah*, a frigate for service in the Pacific, in 1847. He passed his examination for lieutenant in 1851, and, coming home shortly afterwards, was appointed to the *Resolute*, and sent to the Arctic in the expedition under Captain Sir E. Belcher in search of the Franklin Expedition. His service up to the time he was a lieutenant was entirely in sailing vessels, the motive power of which was the wind applied to the propulsion of vessels by masts, yards, and sails, and this early training made him a thorough master of managing vessels in all circumstances of wind and weather, and although during his service after returning from the Arctic in 1854 he was employed in vessels that were furnished with auxiliary steam power, he was always pleased when he could navigate his vessel under sail alone. One instance of this may be given. When at Malta in the *Newport* in 1869 the chief engineer of that vessel, who was anxious not to go to sea on the day named because he wanted to attend some function on shore with his wife, asked to be given forty-eight hours to take off the cylinder covers, Captain Nares, as he then was, replied: "By all means." The chief engineer was jubilant, but on the day originally named, after the usual morning muster by division, the order was given "Hands make sail," and the ship sailed out of the harbour, much to the chagrin of the engineer staff. This was a good lesson given with tact and judgment.

During his service in the *Resolute* he took part in the sledge journeys in search of any remains of Franklin. It is not generally known that Arctic sledging was introduced in order to search all the coasts which could not be reached by the vessels for any token of the Franklin Expedition. The ice near the coast is, as a rule, comparatively smooth, consisting of new ice found on the surface between the grounded bergs and the shore line, and this ice is less difficult to travel over than the hummocky ice found in areas off the shore where floes get piled up one on the other from various causes, consequently the sledge parties were able to cover long tracts and to delineate the coast line of numerous islands and straits.

Returning from the Arctic in 1854 he was promoted to lieutenant on October 21, and was sent to one of the armour-plated bombs, constructed specially for the war, 1854–6, for service in the Mediterranean.

From the Mediterranean Nares was transferred to the training-ship for naval cadets, then recently established (1) in the *Illustrious,* and (2) in the *Britannia,* and whilst so serving compiled "The Naval Cadet's Guide and Seaman's Companion." Promoted to commander at the end of 1862 he served in the *Boscawen,* another training-ship, and was then sent to a paddle-wheel vessel, the *Salamander,* engaged in keeping open communication with a party of marines established at Cape York. In his voyages backwards and forwards between Sydney and Cape York he did some useful surveying work and on his return to England in 1867 was selected for the command of the *Newport,* a vessel commissioned for surveying service in the Mediterranean. The opening of the Suez Canal in 1869 necessitated a survey of the Gulf of Suez, and the *Newport* was selected for this service, and was engaged in it during the winter of 1870–71, but in May, 1871, she was sent to England, and her officers and crew turned over to the *Sheerwater,* which vessel, under Nares, proceeded to the Gulf of Suez in the autumn of 1871, and completed the survey from Suez to Koseir by April, 1872.

On the voyage out the *Sheerwater* was instructed to investigate the Gibraltar Strait current, and Dr. W. B. Carpenter embarked on board to assist in that investigation on behalf of the Royal Society. The work was so well done as to mark out Nares for other scientific work, and when, early in 1872, the Admiralty decided to commission a vessel for exploration of the oceanic basins of the world, Nares was chosen to command the ship, and was ordered home to prepare the *Challenger* for her voyage. Leaving England in December, 1872, the *Challenger* executed a series of sections across the Atlantic, and it was then that the system of sections showing the temperature of the ocean from the surface to the bottom was first introduced. Before that time the temperatures were merely plotted in curves. This system of sections gradually revealed the fact that over certain areas the temperature at the bottom remained the same, but that in other areas, adjacent to the first area, the bottom temperature differed, although remaining constant over another considerable space. From this fact it seemed likely that in areas where at equal depths the temperature at the bottom differed in areas adjacent to each other, the difference was caused by a submarine ridge which prevented free circulation. Thus it was known that whilst the Mediterranean had a uniform temperature of from 55° to 56° below a depth of 100 fathoms, the water of the Atlantic adjacent to the Mediterranean decreased in temperature gradually to 36°. The soundings in Gibraltar Strait, just outside the entrance between Cape Spartel and the Spanish coast, revealed the existence of a submarine ridge, and it was then considered probable that in all areas differing much in temperature at equal depths the difference could only be accounted for by the existence of submarine ridges.

The *Challenger* reached the Cape of Good Hope in November, 1873, and in December left for Kerguelen Island to examine a suitable spot for observing the transit of Venus in 1874. This necessitated a triangulation of Kerguelen and a determination of its position. Three weeks were occupied in the work, and records were deposited in cairns to inform the transit of Venus party of the spots considered suitable for the observations. Leaving Kerguelen at the end of January, the *Challenger* then proceeded to the southward as far as the Antarctic Circle to investigate temperatures and depths, and during that cruise, all on board had an opportunity of appreciating the skill of Captain Nares in handling his vessel amongst the icebergs. Gales and snowstorms were not infrequent, and Captain Nares, after consideration, adopted the plan of keeping close to a berg under steam, during night, or in mist or snowstorms, and thus preventing the vessel drifting or sailing into danger. Arriving in Melbourne in March, 1874, and at Sydney in April, the ship was docked and re-fitted, and it was curious to observe how the copper on the bottom was quite corrugated from the strains encountered during the southern voyage. From Sydney the *Challenger* took other oceanic sections across the southern part of the Western Pacific, from Sydney to Wellington, N.Z., from Wellington to the Fiji Islands, and from the Fiji Islands to Raine Island, Australia. From Raine Island the vessel proceeded through the Arafura Sea, the Banda Sea, the Sulu Sea, and the China Sea to Hong Kong, at which port she arrived in November, 1874. On this voyage it was again noticed that the area of some parts of the Sulu Sea differed greatly in temperature at the bottom from the adjacent seas.

At Hong Kong Captain Nares was recalled to England to take command of an expedition about to be organised for Arctic research.

That expedition consisted of two vessels, the *Alert* and *Discovery*, and its primary object was to reach, if possible, the North Pole. Leaving England in the summer of 1875, the vessels proceeded through Davis Strait to Smith Sound, where a secure harbour was found in which to moor the *Discovery*, to form a base of retreat, whilst the *Alert* pushed northward as far as was possible. The ice in the northern part of Smith Sound presented unexpected obstacles, and subsequent observations showed that the polar basin northward of Smith Sound produced masses of icebergs and floes which, being drifted against the coast, were piled one on the top of the other and closed all navigation excepting between the coast and the ice grounded near it. Here, again, the skill of Captain Nares guided the vessel into a fairly secure position between the coast and the grounded ice, a position which it would have been unsafe to take excepting for the *Discovery* left in a secure harbour as a base to fall back on. The winter of 1875–6 was spent in organising sledge parties, one of which, under Commander Markham, was to get as far northwards as possible, one under Lieutenant Pelham Aldrich was to proceed along the coast line in a north-westerly direction, and the third, under Lieutenant Beaumont, was to cross Smith Sound and proceed northward along the Greenland coast. The expeditions along the coast line were successful, as there the ice offered comparatively little obstruction to sledge work, but the rough, hummocky ice encountered by the party under Commander Markham proved to be of such a nature that progress to the northward was very slow and difficult, and the hardships which his party underwent can scarcely be exaggerated.

The sledge parties returning to the vessels towards the end of the summer, Captain Nares decided that it was useless trying to reach the pole from Smith's Sound, and proceeded homewards. The manner in which the *Alert* was extricated from her perilous position and brought safely to England with the *Discovery* was a feat of seamanship any man might be proud of.

After his return from the Arctic Captain Nares was made K.C.B., in recognition of his services, and in 1878 was again given command of the *Alert* to prosecute surveying work in Magellan Strait, but was recalled from that ship in 1879 to act as Marine Adviser to the Board of Trade. This appointment he held for about twenty years. During his retirement, like many another sailor, he took up gardening and was very successful in growing roses.

He died on January 15 and was buried at Long Ditton Church on January 19. The funeral was attended by Captain J. F. Parry, R.N., the hydrographer, who represented the Admiralty, and by several naval officers, most of whom received their first instruction in seamanship from him on board H.M.S. *Britannia*, and many of whom were associated with him in his Arctic Expedition or in the *Challenger* exploring expeditions.

NOTES.

THE Executive Committee of the proposed Meteorological Conference at Edinburgh has handed over to the Scottish Meteorological Society the balance of the funds subscribed for the expenses of the meeting with the hope that when the opportunity once more arises the society will take the initiative in carrying the project into execution. It has been decided that the committees in London and Edinburgh shall be kept in being.

WE learn from *Science* that Prof. J. H. Pettit, professor of soil fertility in the college of agriculture and chief of soil fertility in the experiment station of the University of Illinois, died on December 30 at Pasadena, California; and that Prof. S. B. Christy, professor of mining and metallurgy in the University of California and dean of the college of mining, died in Berkeley, California, on November 30, 1914, at the age of sixty-one years.

PROF. GEORGE FORBES, who has been entrusted by Lady Gill with the duty of preparing a memoir of her late husband, asks us to announce that he would be glad to be favoured with any letters which have been preserved by Sir David Gill's numerous correspondents; and would greatly appreciate any notes—narrative, historical, appreciative, or anecdotal—relating to Sir David's life and personality. All original letters or other documents will be carefully preserved, and returned to the senders at as early a date as possible. Such communications should be addressed to Prof. Forbes at 11 Little College Street, Westminster.

OWING to the war, the fifth International Congress of Philosophy, arranged to be held in London next September, has been abandoned. The General Organising Committee has expressed an earnest hope that the confederacy of the entire philosophical world, which has subsisted since the inauguration of the series of congresses in 1900, and seemed to have attained the rank of a permanent institution, will not be set aside for a longer time than outward circumstances render absolutely imperative. The committee has pledged itself as soon as possible after peace is restored to promote the continuance of this international bond, either by renewing the invitation to meet in this country or by obtaining an invitation from a neutral country.

A REUTER message from New York states that at a dinner given on January 14 at the Aero Club of America, Government officials announced a plan of the Post Office Department to introduce into the postal service 2000 airmen, who would carry sacks of first-class mails. The routes have already been selected by the Department, and it is hoped that the Bill authorising this scheme of aerial transportation of mails will pass next Congress. It may be recalled that, with the sanction of the Postmaster-General, an aerial postal service, for the idea and organisation of which Mr. D. Lewis Poole was chiefly responsible, was carried out successfully between Hendon and Windsor on September 9, 1911, that is, in Coronation year. A sack of letters was conveyed between these two places in thirteen minutes, and the experiment created great interest at the time. It may be some years before a regular aerial service is established for the transportation of mails, but the report from New York suggests that we are getting within measurable distance of it.

THE *Chemist and Druggist* announces the death on December 28, 1914, at seventy-three years of age, of Prof. Karl Liebermann, professor of chemistry in the Technical High School, Charlottenburg, Berlin.

THE death of Mr. J. S. Harding on January 11, in his seventy-sixth year, has deprived science of a life-long meteorologist. He had been connected with the Meteorological Office since its establishment in 1854, and was private secretary to Admiral FitzRoy—the meteorological pioneer. He retired in 1906, after a service of more than half a century, leaving behind him an abiding memory, having secured the hearty appreciation of the committee and council of the office and the sincere friendship of his colleagues. All who knew Mr. Harding have reason to remember his ever-courteous personality and willingness to help inquiry into meteorological literature in any direction. He had been a member and fellow of the Royal Meteorological Society since 1866, and had contributed valuable work to the researches of the society. He had mastered the chief European languages—a notable asset for the study of international meteorology—and was an esteemed contributor to the columns of NATURE to the very week of his passing into silence.

DR. DE FILIPPI has reported to the Royal Geographical Society at some length upon the work of his expedition in northern Kashmir. Two parties, led respectively by himself and by Major Wood, have gone far to establish knowledge of the topography of the Remo glacier basin and the watershed between it and the Karakoram pass. Their researches appear to necessitate the substantial modification of existing maps, in regard not only to the extent of glaciers, but also to the position of the watershed and defluent valleys. The Remo glacier-field is found to feed both the Indus and the Yarkand systems, and thus to send some of its water down either slope of the Himalayan system, to the Arabian Sea on one hand, and to the Tarim depression in the Central Asian desert on the other. The expedition is continuing its work, which has been extended into Chinese Turkestan.

THE Russian Supplement which accompanied the *Times* of January 15 dealt mainly with economic aspects of the war as especially affecting that country, and some of them, such as the question of the position of the chemico-pharmaceutical industry, call for scientific attention. The possible development of British and Russian commercial relations is treated of at considerable length, and among other interesting commercial discussions are those dealing with the sudden strain placed upon the port of Archangel, with the arctic sea route to Siberia, and with other facts and problems of communication. In another department we find a study of the distribution of Germans in Russia, accompanied by an instructive map, which shows how Germans have established themselves in greatest numbers in some of the best provinces (not necessarily nearest their own frontier), and how they largely populate also some of the great towns, with important political results. Another article discusses the tribes of the Yenisei valley.

ON several occasions recently, writers in the daily Press have suggested that the barbarous methods of warfare adopted by German forces represent the natural result of close attention to scientific teaching, and we are warned against letting our educational institutions be dominated by the same materialistic spirit. It would be juster to associate the humanities rather than science with the cause of the present war, and to say that whatever success has been achieved by the enemy is due to the application of scientific knowledge. There is, unfortunately, little danger that science will be given a prominent or important place in our schools or universities, or that our public men, officials, and writers will understand that it is not only essential to national welfare, but also in addition an intellectual outlook and a standard of truth. The only literary man who knows these things and endeavours to impress them upon the public mind is Mr. H. G. Wells; and for his efforts to awaken the British people to a sense of what their neglect of systematised natural knowledge signifies, we cannot be too grateful. An article by Mr. Wells in the *Daily Chronicle* of Januarv 19 describes truthfully the discouraging conditions attached to scientific study in this country, and the mental inertia which has to be overcome before use is made of scientific knowledge or expert opinion. He pleads for the organisation of a thinking department for collecting, testing, and developing new ideas, such as was referred to by Lord Selborne in the House of Lords a few days ago, and his forcible words may perhaps stimulate interest in intellectual activity for the benefit of the State. It has never been more necessary than it is now to insist upon fuller recognition of the claims of science in education and in public affairs, and for that reason we hope that Mr. Wells will make further and similar contributions to national enlightenment.

THE evidences in favour of the protective treatment against typhoid fever are of many kinds. There is the analogy between this protective treatment and the protective treatments against cholera, anthrax, and plague. There is the authority of the years of hard work spent by men of science over the bacteriology of the fever. There is the whole strength of the medical profession; Sir William Osler and Sir Lauder Brunton have well said, in the *Times*, what their brethren are saying everywhere. Above all, there is the final and irreversible judgment of nature herself. We read, only a fortnight ago, how she has tested this treatment, in northern France and Belgium. Our men in the field may be divided into three classes: (*a*) fully protected, (*b*) partly protected, (*c*) non-protected. The proportion of cases has been 1, 6, and 16; that is to say, the non-protected have been punished sixteen times more than the protected. We read, only a few days ago, how nature made a similar experiment among the French troops in the field. That seems to be her invariable rule, to pick out the unprotected. How could she do otherwise? What else do we expect of her? For we have got this protective treatment straight from her; it has been copied out of her book. We protect our men from having typhoid once, by giving them a dose of the very stuff which she gives them to protect them from having typhoid twice. The treatment is not perfect; but it does protect our men from the misery of illness or death, and from the grave offence of spreading infection among their friends. Meanwhile, the anti-vivisection societies are hard at work, doing all that they can to rob our men of this protection; and that by methods which are singularly repugnant to public opinion.

THE announcement that the King has been pleased to approve the grant of a Royal Charter of Incorporation to the Institution of Mining and Metallurgy, is one of interest and importance to those interested in the mining industry, as well as to the profession represented by the institution. Its objects are defined in the charter as for "the advancement of the science and practice of mining in respect of minerals other than coal and of metallurgy in respect of metals other than iron." The institution was founded in 1892, and its founders wisely based qualification for membership upon strictly professional lines, avoiding the temptation, which some other kindred societies were unable to withstand, to open the door wide from considerations of finance. This test for admission to its ranks has been maintained and strengthened in the intervening years, and a high professional standard has been attained by rigidly scrutinising the statements of candidates for admission and by direct inquiry with a view to their confirmation. The council also has the right, which is exercised, to investigate cases of alleged breach of professional conduct, and to expel any member against whom such a charge has been substantiated. In 1905 the membership of the institution was 1324, and at the end of 1914 it was 2500. The institution occupies its own freehold house at No. 1 Finsbury Circus, E.C., and has an ordinary income of more than 5000*l*. Its influence for good in the educational, technical, and professional world has well merited the recognition bestowed upon it by the Crown.

AMETHYSTS were used extensively by the ancient Egyptians, and it has hitherto been a puzzle whence they obtained the stone. In the *Cairo Scientific Journal* for August, 1914, Mr. G. W. Murray reports that he and Mr. C. M. Firth recently found a piece in Wadi Bahan in lower Nubia, and in May this year Mr. G. B. Crookston discovered considerable workings for amethyst near Gebel Abu Diyeiba, and practically on the footpath between the phosphate mines of Wasif and Um Huetat. The workings are very extensive, and the amethysts occur lining cavities in a kind of red granite. These cavities occur along veins in the granite, which run in remarkably straight lines for hundreds of yards.

WITH reference to Dr. Bastian's paper on the production of fungus-germs and other living forms from Zooglœal masses (NATURE, December 24, 1914, p. 462) Dr. Margaret C. W. Young directs attention to work she has carried out on the apparent development of very different forms of living organisms from a single parent one. Thus by heating spores of *Bacillus subtilis* in a weak alkaline solution to 110° C., colonies of cocci, streptococci, and yeasts were observed to develop. By other treatment *subtilis* cultures seemed to pass into protozoal stages. Dr. Young holds that bacteria of the *B. subtilis* and *mesentericus* groups are really sporozoites of a protozoon the life-history of which embraces amœboid, flagellate, sporulating, and granular forms. In this, the sexual part of the cycle, the organism is almost invariably parasitic. Outside the host, it exists in fungal forms which may range from a coccus to an aspergillus (*British Medical Journal*, September 25, 1909, and October 3, 1914).

To Captain Stanley Flower, director of the Giza Zoological Gardens, we are indebted for a copy of a new issue of his list of the zoological gardens of the world, apparently published at Cairo. In normal times the list should have been revised up to the end of 1914, and published in January, 1915; but the war rendered this impracticable, and it is therefore corrected only down to the end of July last. The entries include 166 different establishments, public and private.

IN NATURE of July 9, 1914 (p. 478), a letter was published from Mr. Lydekker in which it was stated that an okapi sent home by Dr. Christy from the Belgian Congo had been mounted with true horny sheaths on the bony horn-cores. To make sure that there had been no mistake Mr. Lydekker wrote to Dr. Christy, who is now in the Congo, asking whether the animal had been correctly mounted in this respect. We understand that in a reply just received Dr. Christy says, "quite correct."

THE opening article in the January number of the *Museums Journal* is devoted to the Royal Natural History Museum of Belgium (see p. 404). Although Belgium possessed natural history collections of considerable value at a much earlier date, it was not until 1846 that the museum in Brussels was placed on a permanent footing, Vicomte du Bus, who did such good work on the fossil whales of the Antwerp Crag, being the first director. A new era in the history of the institution was inaugurated when Dr. E. Dupont was appointed director in 1868. In 1891, under the same director, the transference of the collections to a building in the Parc Leopold, originally constructed for the offices of the old zoological gardens, was completed, and the new museum, as it had now become, was opened by H.M. King Leopold II. The accommodation was soon, however, found to be altogether inadequate for the proper housing and display of the collections; and a comprehensive scheme of additions was planned. Only a portion of this scheme has, however, yet been carried out—the remainder is likely to remain *in nubibus* for many a long year.

THE last number of the Journal of the Quekett Microscopical Club is especially interesting in containing a report of the 500th ordinary meeting. Mr. A. E. Hilton has a useful note on the continuous cultivation of the Mycetozoon *Badhamia utricularis* on moistened bread, to which from time to time there may be profitably added a mixture of ammonium phosphate and cane-sugar. The minimum visibile (apart from the ultra-microscope) is discussed by Mr. A. A. C. Eliot Merlin, who finds that the diameter of a particle just visible under a 1/12th apochromat with a working aperture of 1·4 is 1/377,358th of an inch. The diameter of the flagellum of *Bacterium termo* was estimated by Dallinger at 1/204,700th of an inch, but Merlin finds it to be about double that, namely, 1/112,200. C. F. Rousselet has a note on the sexual stages of two African species of Volvox, *Volvox africanus* and *V. rousseleti*, the vegetative colonies of which were previously described by Prof. G. S. West. Mr. E. M. Nelson discusses various forms of binocular microscope, a much-needed low-power condenser, and a new object glass produced by Zeiss in which a near approach has been made towards apochromatism without the use of fluorspar. Just as oil immersions have eclipsed water immersions, so will this new lens, according to Mr. Nelson, supersede the wide-angled dry lenses, which should all be scrapped.

THE Kew Bulletin, No. 10, 1914, contains a paper on *Hedychium coronarium* and allied species, which is of value in connection with the interest aroused in these plants as a source of material for paper-making. The eight allied species are chiefly distinguished by the floral characters, of which illustrations are given. It seems probable that all these Hedychiums would be useful for paper-making. It will be remembered that the paper made from this plant is self-sized, and can be written upon with ink directly it leaves the machine without further treatment.

THE native plants of the Azores are discussed by Dr. H. B. Guppy in *Kew Bulletin*, No. 9, 1914. The vegetation of the mountain of Pico, 7613 ft., was particularly studied, with its European flora on the higher levels—ling, St. Dabeoc's heath, thyme, etc.—and the characteristic Azorean plants below 5000 ft., such as *Erica azorica, Juniperus oxycedrus*, and the Azorean holly, *Ilex perado*. The Faya tree, *Myrica faya*, is a dominant tree in the lower woods, but the forest trees generally are small, owing to the depredations of the wood-cutters. The indigenous plants are few, the flora is largely European in character, with a few affinities with Africa and the Canaries, *Myrsine Africana* affording the most remarkable connection with the continent. It seems probable that the flora of the Azores is relatively recent and can be accounted for by existing agencies of dispersal in contrast to the Canaries and Madeira, the flora of which is ancient, dating back probably in part to Miocene times.

THE occurrence of pitchblende in the Quartz Hill district, Gilpin Co., Colorado, is described by Mr. E. S. Bastin in Professional Paper, 90 A, United States Geological Survey (1914). The ore is found in veins with pyrite and copper pyrites, and is connected by the author with Cainozoic intrusions of monzonite (diorite with orthoclase).

SINCE the reference made in NATURE of November 26, 1914 (vol. xciv., p. 348) to the Upper Jurassic fauna of the Spiti Shales of the Himalayas, the study of the mollusca has been continued by Miss Paula Steiger in Vienna (*Palaeontologia Indica*, series xv., vol. iv., fasc. No. 5). The author wisely remarks that the comparison of the brachiopods with Mediterranean forms is due to our far too scanty knowledge of members of the group from other parts of the world. Here we have a hint to palæontologists and collectors.

THE 792 pages of the Annual Report of the Geological Survey of Iowa for 1913, which has just been issued, are almost entirely occupied by an elaborately illustrated account of the materials for roads and concrete throughout the State. This systematic report provides much information about the nature of the glacial and interglacial beds. In places, the imported boulders of gneiss and granite in the thin Iowan drift are as valuable as those in the North German plain, and are similarly collected for use on the macadamised roads.

IN the December number of the *Agricultural Students' Gazette*, Prof. G. S. Boulger discusses some problems of ecology as illustrated by Gloucestershire flowering plants. He divides the factors of ecology into three main groups, (*a*) the inherent characters of the plants, (*b*) the environment, and (*c*) the relations of (*a*) and (*b*). Many species of plants, commonly regarded as characteristic of a particular feature in their normal environment, are found flourishing under conditions where this very feature is notably weak or even absent. Thus, the calcicole or lime-loving Pasque-flower (*Anemone pulsatilla*, Linné) will grow well in a rich garden soil poor in lime; the Bee Orchis (*Ophrys apifera*, Hudson), most commonly found in England on limestone, is also luxuriant on the Upper Lias, near Leckhampton. Again, the Fritillary (*Fritillaria meleagris*, Linné) occurs habitually in meadows liable to inundation, but has been found in a wood near Fairford fully twenty feet above the water level. Another species of riverside plant, the Meadow Crane's-bill (*Geranium pratense*, Linné), abundant by Severn and Avon at Tewkesbury, is not uncommon in seemingly dry hedgerows on the Cotteswolds. Little is known of the precise conditions that determine the topographical distribution of common species, and a plea is put forward for the investigation of these and other interesting problems suggested in the paper.

WE have been favoured with a copy of an interesting address by Dr. F. A. Carpenter (local forecaster) entitled "Flood Studies at Los Angeles," reprinted from the U.S. *Monthly Weather Review* of June last. The object of the paper (which is accompanied by tables and diagrams) is to explain, generally, some of the causes and pertinent features of such rain storms, and to investigate more particularly that of February 18–21, 1914. The rainfall of South California is subject to great variations; the average annual fall at Los Angeles is 15·5 in., the extremes being 5·6 in. (1898–9), and 38·2 in. (1883–4). Rain only occurs during parts of the year; South California would be practically rainless were it not for the southern deflection of the paths of some of the northern storms. During the past thirty-seven years the harbour of San Pedro (near Los Angeles) has only been silted up five times by floods, although the latter are of frequent occurrence. When the first rain is steady it soaks into the land, and no floods occur; but during the next period of rainy weather they generally take place. Dr. Carpenter's useful paper should be read in conjunction with Prof. A. G. McAdie's elaborate memoir on the "Rainfall of California" (NATURE, October 15, 1914).

IT is not so long ago that *Punch* published a cartoon of artists painting pictures intended to represent "old masters," of which one-half had been restored by a particular process. In the *Museums Journal* Mr. I. J. Williams, of the Welsh National Museum, describes his experiences in cleaning pictures himself after vainly attempting to obtain satisfactory results by employing outsiders. The process is, of course, comparatively simple, involving nothing more than rubbing off the old varnish with cotton-wool dipped in a mixture of four parts of methylated spirit to one of turpentine, but he finds that considerable skill is required in stopping the process at exactly the right stage. With a view to the future preservation of the pictures it would, however, be desirable to make very careful inquiries as to the character of the varnish subsequently used, as it is not improbable that the old varnishes were better than any now obtainable.

OWING to the decreased output of scientific work in consequence of the war the concluding numbers of *Science Abstracts* for the year 1914 are somewhat less extensive than usual. The physics part consists of forty pages of abstracts and four of index, and the electrical engineering part of thirty-one and four pages respectively. The actual number of abstracts in the two parts is 104 and sixty-two. The average length of the engineering continues to be greater than that of the physics abstract, mainly on account of descriptions of engineering plant. Both sections of the publication continue to supply up-to-date and trustworthy information as to the advances made in many fields, and it is difficult to see how any scientific or technical worker in either subject could now dispense with *Science Abstracts*.

ACCORDING to an editorial note in the *Scientific American* for December 26, 1914, a series of articles will be published early in the present year dealing with the necessity of encouraging in every possible way the scientific researcher in order to make the industries of America more independent of Europe. The editor is of opinion that many manufacturers who at present depend on Europe for some portion of their raw material for technical processes could, by stating their difficulties to a man of science willing to undertake the necessary research, obtain at a relatively small cost information which would place them on a much firmer footing. We have no doubt these articles will be read with interest in this country, as the attitude of the British manufacturer towards research is by no means so cordial as it ought to be.

A POPULAR edition of Prince Kropotkin's "Mutual Aid: A Factor of Evolution," has been published by Mr. William Heinemann, at the price of 1*s*. net. This cheap re-issue of an important work appears at an opportune moment. Many German writers are excusing the horrors of the war by representing them as unavoidable consequences of the struggle for existence. As our review of the first edition of "Mutual Aid," in the issue of NATURE for January 1, 1903 (vol. lxvii., p. 196), pointed out, Prince Kropotkin shows that in the case of animals, there is very little evidence of any struggle for existence among members of the same species, and no justification can be found for the crude conception of Darwinism which places selfish interests among the desirable attributes of the human race. We welcome this cheap edition of Prince Kropotkin's noteworthy exposition of evolutionary ethics, and we hope it will have the wide circulation its lucidity and charm deserve.

THE Cambridge University Press will shortly issue a new edition—the third—of "Zoology," by Drs. Shipley and MacBride. The work has been thoroughly revised, many portions being re-written, and several new illustrations added.—Messrs. Methuen and Co., Ltd., announce the forthcoming publication of a further selection of Sir E. Ray Lankester's popular science articles. It will be entitled "Diversions of a Naturalist."

OUR ASTRONOMICAL COLUMN.

SPECTRAL LINE DISPLACEMENTS AT THE SUN'S LIMB.—As a further research in connection with the work carried on at the Kodaikanal Observatory on the displacement of spectrum lines at the sun's limb, Mr. A. A. Narayana Ayyar contributes to Bulletin No. 44 of the Kodaikanal Observatory the results of his work on the displacements at the sun's limb of lines sensitive to pressure and density. It is pointed out that certain lines, particularly those of calcium and sodium, are much more sensitive to pressure and density than iron lines, and that therefore the limb shifts of such lines should provide a much more rigorous test as to whether there is a large difference of pressure and density between the sun's limb and centre. The paper gives the experimental details, and the result arrived at is that the difference of pressure and density between the limb and centre is very small, a conclusion in agreement with that derived by Messrs. Evershed and Royds. The balance of evidence, as the author states, is in favour of slightly lower pressure and density at the limb than at the centre of the disc.

STATISTICS OF SPECTROSCOPIC BINARY STARS.—In the *Arkiv för Matematik, Astronomi och Fysik* (vol. x., No. 6) of the Stockholm Academy, Dr. Sven Wicksell contributes a paper on the statistics of spectroscopic binary stars. Referring in the first instance to the important investigations and discussions by Campbell, Schlesinger, Baker, Ludendorff, etc., he attempts to find out other interesting properties of spectroscopic binaries. Constructing a card-catalogue of 440 binaries, he found it was composed of 104 systems, of which the period was known, seventy-nine in which the semi-amplitude of radial velocity was known and seventy-five in which the excentricity was known. All these he divided into four classes, according to their spectral type, and arranged them in tabular form. The investigation is devoted to the study of the frequency curves of the period, the explanation of the existence of two groups of periods, a reference to Shapley's investigation of eclipsing binaries, etc., and, finally, the distribution of spectroscopic binaries as regards the Milky Way.

THE NATURE AND CAUSE OF CEPHEID VARIATION.—Dr. Harlow Shapley, in the December number of the *Astrophysical Journal* (vol. xl., No. 5, p. 448) presents a discussion on the nature and cause of Cepheid variation, in which he investigates the question of whether or not the usually accepted double-star interpretation of Cepheid variation should be abandoned. From the spectroscopic point of view alone, he states, the Cepheids stand out as unexplainable anomalies. There are persistent peculiarities in the spectroscopic elements, a universal absence of a secondary spectrum, and minute apparent orbits. They do exhibit definite periodic oscillations of their spectral lines, as is the case with ordinary spectroscopic binaries, which may be interpreted as periodic orbital motion. In the present discussion, which the author considers only as preliminary, no complete explanation of Cepheid variation is offered as a substitute for the existing inadequate theories, but he points out the direction in which he thinks the real interpretation seems to lie. The sections of the present paper are devoted to the principal results which he has obtained from an extensive investigation, details of which will be published in subsequent papers. The main conclusion which he has reached is summed up by him as follows:—"That the Cepheid and cluster variables are not binary systems, and that the explanation of their light-changes can much more likely be found in a consideration of internal or surface pulsations of isolated stellar bodies."

THE PREHISTORIC SOCIETY OF EAST ANGLIA.

MR. MILLER CHRISTY, in the Proceedings of the Prehistoric Society of East Anglia, 1913–14, discusses the curious engraved shell from the Red Crag at Walton-on-the-Naze, which has formed the subject of much controversy since it was exhibited at the York meeting of the British Association in 1881. It is a crude and inartistic attempt to depict a human portrait. It is much ruder in its execution than the celebrated drawings of the human figure from the French caves and the Bushman drawings from South Africa. It also differs from other drawings of this kind as it represents, not a profile, but a full face. The characteristics of this supposed portrait have been investigated by a special committee, and on the whole Mr. Christy is disposed to agree with its members that the evidence is insufficient to enable us to reach any definite conclusion regarding its age.

Under the title of "An Early Norfolk Trackway: The Drove Road," Messrs. W. G. Clarke and H. D. Hewitt describe a supposed ancient trackway, fourteen miles in length, connecting the fenland at Blackdike, Hockwold, with Peddar's Way on Roudham Heath. There are some indications that this was an ancient route, but the evidence adduced in support of the conclusion that it is of extreme antiquity is not quite conclusive. In its original state it possesses many points of resemblance to known prehistoric trackways in East Anglia and other parts of England; it is subsidiary to Peddar's Way, and it is also connected with the Pilgrim's Walk; in relation to the Fendyke it resembles the Icknield Way, which is certainly prehistoric; roads from Saxon settlements were in some cases diverted from their natural course by the Drove; there are barrows in the vicinity, and flint implements and ancient pottery have been found in the neighbourhood. Another similar road near Norwich is described by Mr. Walter Rye in the same issue of the Proceedings.

ANNUAL MEETING OF THE PARIS ACADEMY OF SCIENCES.[1]

THE year just ended has been broken by a formidable discontinuity. In the first period our work has followed its usual course; in the second, it has been dominated by the constant thought of national defence.

The importance of the rôle of our academy grows from year to year. Nearly all the development of modern civilisation takes its roots in scientific research; that is to say, in the study, the co-ordination and the generalisation of those facts and ideas which lend themselves to exact measurements or precise comparisons. The domain of science thus understood is unlimited; it ranges from the highest abstractions to the most practical applications, from the world of stars and nebulæ to that of atoms and molecules; from the mechanics of worlds to factories, to armoured vessels, and to aeroplanes; from the delicate phenomena of physics and chemistry to the great industries, to telephony, to wireless telegraphy, and to explosives; from the most complex living organisms in the present and the past to microscopic beings; from the experiments of physiology and microbiology to agriculture, medicine, and surgery. If, at all times, the evolution of philosophy has followed that of science, modern work on the principles of geometry and mechanics, the examination of the ideas of space and time, the daring attempts to connect simultaneously these two ideas with the theory of groups of transformations, have opened entirely new paths in the study of the foundations of our knowledge.

The search for scientific truth by a mind enamoured of moral beauty is the noblest aim of mankind. But the study of science, deflected from the steady ideal of right and humanity, confined to the path of a narrow specialisation, disciplined with a view to domination and reduced principally to practical use, leads rapidly to a civilisation of selfishness, hardness, and materialism, to a kind of learned barbarity like that which has gradually overgrown the Germany of the present day. Granted that the acquisition of the scientific spirit is indispensable to education, other elements should be joined to it to form a man worthy of the name, and these are presented to us by the "humanities," which are studied by our colleagues of the other academies; philosophy and history, religious and social science, the rights of individuals or of nations, the creations of thinkers or of artists.

Instruction and erudition must not be confused with education, the laborious work of acquiring knowledge with the development of civilisation. True education ought to create a personal religion, a conscience increasing in sensitiveness and loftiness of ideal, the love of clearness, the power of forming general ideas, devotion to justice, respect for other men.

This is the well-balanced culture after which France has always sought; it is this which is threatened to-day; at the sight of this danger Prof. Murray Butler, of Columbia University, has said:—

"What are we to think? Is science a sham? Is philosophy a pretence? Is religion a mere rumour? Is the great international structure of friendship, good-will, and scholarly co-operation upon which this university and many of its members have worked so long, so faithfully, and apparently with so much success, only an illusion? Are the long and devoted labours of scholars and of statesmen to enthrone Justice in the place of Brute Force in the world, all without effect? The answer is No; a thousand times, No!"

The American conscience has thus formulated the universal reply, which is a certain proof of victory for our ideal.

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[1] Translation of the main part of the address delivered on December 21, 1914, by the president, M. Paul Appell.

Amongst the scientific events of the year, prominent mention is due to the unveiling of the monument of our colleague Marey, one of those men to whom modern physiology owes so much. As M. Richet has said ("Inauguration du monument élevé à la memoire de Etienne Jules Marey, au Parc des Princes, à Boulogne-sur-Seine, le mercredi 3 Juin, 1914"; Paris: Gauthier-Villars), he is one of those who leave a work so firm, so fruitful, so perfect that every year adds to its renown. In fact, time takes no toll on a well-founded scientific work. The pages of Descartes on "la Géométrie analytique," of Harvey on "the contractions of the heart," of Lavoisier on "les combustions respiratoires," remain intact and intangible, like the Greek marble statues, the beauty of which remains unchanged after a lapse of twenty centuries. The idea conceived by Marey in his youth and realised by him in his work was the creation of methods permitting the direct and precise inscription of motion, either by graphical records, or by photographs taken at intervals so short as to appear continuous. A running man, a galloping horse, a flying bird, a beating heart, execute movements only a confused average of which can be seized by the eye. The photographs of Marey give an exact analysis of them; it is only necessary to realise the synthesis of the successive images by the aid of a method employed a long time ago in certain toys to obtain a kinematograph. This apparatus, possessing innumerable scientific applications, has then its origin in the work of Marey.

It presents the great philosophic interest of giving control of the time, which, until then, had been the one independent variable. Once a phenomenon is recorded it can be repeated in its successive phases, accelerating or retarding at will. Thus deceleration permits the study at leisure of the beats of the heart, the movements of a bird's wings, and acceleration shows in a few minutes the germination of a plant or the hatching of an egg. It is even possible to change the sign of the variable and reverse the order of events. Marey then was an inventor of genius, a man who extracted something from nothing; the improvement of a discovery is a small matter, the essential point is to make it.

This year French physicists have been actively occupied with the construction of a huge electromagnet, in which the intensity and dimensions of the field were to be much greater than those of the most powerful apparatus in current use. A magnet of this nature would permit of absolutely new researches on the magnetic properties of matter at different temperatures, on the constitution of crystals, on Zeeman's phenomenon, rotatory magnetic polarisation, and, in another order of work, on modifications of vital phenomena under the action of the magnetic field. The council of the Faculty of Science of Paris, struck with the importance of these researches, had reserved from the funds placed at its disposition by the liberality of M. Commercy for the advancement of science a sum of 50,000 francs, as a first contribution, although small, to the total expenditure required for the realisation of the scheme. Prince Bonaparte, who is always ready with active generosity to support great French scientific enterprises, has taken an active interest in this question. At his request an official committee, composed of the most competent members of our academy, was constituted, in order to study under what conditions France could be endowed with an instrument that should be unique in the world. This committee has held numerous meetings to discuss the various suggestions and hear the best-known specialists; its results have been published in a pamphlet which is a credit to our academy. Without quoting any names, the conclusions may be summarised thus: it is desirable that an important laboratory of magnetic research should be created; this laboratory should be placed under the patronage of the academy, and administered by the University of Paris; in this laboratory should be installed the most powerful electromagnets of the types chosen.

While we are thus dreaming of a gigantic magnet destined to enlarge the field of human knowledge, Germany, carried away by its dream of world-domination, prepared in secret enormous mortars in view of a sudden overwhelming attack on Belgian and French fortresses; when the time was thought favourable, war was declared against Russia and France, and Belgian neutrality was violated. Since the first days in August our academy has had but one thought, to assist the Government in the defence of the country and liberty.

At the meeting of August 3, the academy notified the Government that all its members who were not mobilised in the public service held themselves in readiness to aid in the national defence, each according to his speciality. After the meeting six large committees were constituted under the following denominations:—(1) Mechanics (including Aviation); (2) Wireless Telegraphy; (3) Radiography; (4) Chemistry (including Explosives); (5) Medicine, Surgery, Hygiene; (6) Food. All these committees have worked their hardest; the time has not come to speak of the reports which they have presented and the results they have obtained.

On August 10 the academy addressed to its correspondants in Belgium, M. Boulvin at Ghent, and M. Francotte at Brussels, the expression of its brotherly friendship and its profound admiration for the Belgian people and army. We solemnly renew to-day the expression of these sentiments, adding our indignant protest against the destruction of the treasures of art and science; the acts of violence on the liberty, life, and property of the non-combatants, committed deliberately in order to punish noble nations because they did not hesitate in their choice between the laws of honour, the respect for treaties, the love of independence, and the base suggestions of material interest or of fear.

MATHEMATICS IN ARTILLERY SCIENCE.

SIR GEORGE GREENHILL, president of the Mathematical Association, delivered an address upon "Mathematics in Artillery Science" at the annual meeting of the association on January 9. We have been unable to obtain a copy of the address from the officials of the association, though we think that one of the chief purposes of a scientific society should be to secure as wide a publicity as possible for its papers and addresses. Sir George Greenhill's remarks have, however, been summarised in the daily papers, and from the *Times* report the subjoined abstract has been derived. We may add that as Sir George was formerly professor of mathematics in the Artillery College, Woolwich, his opinions upon the position which science occupies in our technical training for modern warfare must be given careful consideration.

Six months ago artillery officers would have said there was no such thing as mathematics in artillery science; but that outlook was now ancient history, for at the present time we are engaged in what is, in fact, a mathematical war. Drawing upon his experience as a professor of artillery theory for instances where science would prove itself useful on service, he explained how particulars of the enemy's guns could be deduced from fragments of the wall of a shell and photographic pictures. From a fragment they could determine whether a shell came from one of the 42-centimetre howitzers, the very existence of which still appeared in doubt. Dealing with the calculations for ascertaining how far men should stand from a gun to avoid the danger of permanent deafness, he said they need not fear to stand 12 yards behind the 42-centimetre howitzer; and so the story was discounted of the firing party taking cover 100 to 200 metres away when this howitzer was fired. An application of the theory of the conduction of heat would have reassured our men that life in the trenches would not be too cold, or would at least be warmer than in the frost above, provided only the floor could be drained dry under foot. It had also to be borne in mind that the trench gave better cover than a tent.

Five years ago he had an invitation to Berlin, to visit the Military Technical Academy there. It was a magnificent institution such as we could not afford, so our rulers assured us. Prof. Cranz showed how in his department no money was spared in recent equipment, including a bomb-proof range available for artillery fire and yet in the heart of a big city. There were plenty of outdoor artillery ranges also to visit, where instructive work was in progress. The Perry system of education was adopted in Berlin. After a lecture on wireless telegraphy, the class was set to work, as he saw, in making the antennæ which had played such an important part in the war. Sixty officers were under instruction at a time for a course of three years, and he was assured their zeal was admirable. It was considered such bad form not to give the best in return for the honour and glory of the Fatherland. But our Regular was apathetic by comparison. We must put our trust in the junior ranks to push old Apathy from his stool and carry us through this war.

It was a mournful contrast to revert to Woolwich. There they had been evicted and were told to found a new artillery college with the choice of a cellar under some stables or a kitchen and scullery and bare walls in a deserted hospital, there to organise victory and at no expense. With the courage of an Austrian general compelled to maintain his muzzle-loading musket a match for the Prussian needle-gun, the Military Director assured them that there was nothing superior to be found at Greenwich, in the Naval College there lodged in the old Palace. Such dismal, penurious surroundings had a disastrous effect on the *genius loci,* and they never really recovered from a downhearted spirit not calculated for victory. Our military science was under the rule of Thumb, the official genius. His fumbling method was considered a match for disciplined theory.

We saw already how the cost had been well laid out in this war of the Berlin Military Technical Academy, the German jumping off with a lead he was able to keep so far. The finished article of the academy was employed in the dissemination of true theory and in the scientific direction of warlike preparation as at Krupps. Assuming everything for the best for the Allies, and if we lived to go in again at Antwerp, an interesting match would be watched between our artillery science and the German, to see how long it would take us to get the other side out, compared with our own innings and the time we kept our wicket up. No long-range fire, he had been assured, was ever going to be of any use again, involving theoretical calculation. The word was "Gallop up close, to 400 yards, and let them have it."

The country was furious at the way our poor fellows were pounded mercilessly at the start by long-range accurate howitzer fire with no protection from our own side. King George's stirring appeal, "Wake up, England," was intercepted by our rulers, and it was England the Unready again when our Senior Lethargy bumped into the Titanic Energy of the German Empire.

SOME ASPECTS OF PROGRESS IN MODERN ZOOLOGY.[1]

IT is our privilege to live in a time of almost unexampled progress in natural science, a time distinguished alike by discoveries of the first magnitude and by far-reaching changes in method and in point of view. The advances of recent years have revolutionised our conceptions of the structure of matter, and have seriously raised the question of the transmutation of the chemical elements. They have continually extended the proofs of organic evolution, but have at the same time opened wide the door to a re-examination of its conditions, its causes, and its essential nature. Such has been the swiftness of these advances that some effort is still required to realise what remarkable new horizons of discovery they have brought into view. A few years ago the possibility of investigating by direct experiment the internal structure of atoms, or the topographical grouping of hereditary units in the germ-cells, would have seemed a wild dream. To-day these questions stand among the substantial realities of scientific inquiry. And lest we should lose our heads amid advances so sweeping, the principles that guide scientific research have been subjected as never before to critical examination. We have become more circumspect in our attitude towards natural "laws." We have attained to a clearer view of our working hypotheses—of their uses and their limitations. With the best of intentions we do not always succeed in keeping them clear of metaphysics, but at least we have learned to try. We perceive more and more clearly that science does not deal with ultimate problems or with final solutions. In order to live science must move. She attempts no more than to win successive points of vantage which may serve, one after another, as stepping stones to further progress. When these have played their part they are often left behind as the general advance proceeds.

In respect to the practical applications of science we have almost ceased to wonder at incredible prodigies of achievement; yet in some directions they retain a hold on our imagination that daily familiarity cannot shake. Not in our time, at least, will the magnificent conquests of sanitary science and experimental medicine sink to the level of the commonplace. Science here renders her most direct and personal service to human welfare; and here in less direct ways she plays a part in the advance of our civilisation that would have been inconceivable to our fathers. Popular writers delight to portray the naturalist as a kind of reanimated antediluvian, wandering aimlessly in a modern world where he plays the part of a harmless visionary; but what master of romance would have had the ingenuity to put into the head of his mythical naturalist a dream that the construction of the Panama Canal would turn upon our acquaintance with the natural history of the mosquito, or that the health and happiness of nations—nay, their advance in science, letters, and the arts—might depend measurably on the cultivation of our intimacy with the family lives of house-flies, fleas, and creatures of still more dubious antecedents!

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[1] Presidential address delivered to the American Association for the Advancement of Science, Philadelphia, December 28, 1914, by Prof. E. B. Wilson.

I.

Fourteen years ago to-night it was my privilege to deliver an address before the American Society of Naturalists, entitled "Aims and Methods of Study in Natural History,"[2] in which I indicated certain important changes that were then rapidly gathering headway in zoology. To-night I once more ask attention to this subject as viewed in the fuller light of the remarkable period of progress through which biology has since been passing. I will not try to range over the whole vast field of zoology or to catalogue its specific advances. I will only permit myself a few rather desultory reflections suggested by a retrospect upon the progress of the past twenty-five years. If my view is not fully rounded, if it is coloured by a long-standing habit of looking at biological phenomena through the eyes of an embryologist, I will make no apology for what I am not able to avoid. Let me remind you also at how many points the boundaries between this and other branches of biology have become obliterated. The traditional separation between zoology and botany, for instance, has lost all significance for such subjects as genetics or cytology. Again, the artificial boundary often set up between zoology and animal physiology has wholly disappeared, owing to the extension of experimental methods to morphology and of comparative methods to physiology. I trust therefore that our brethren in botany and physiology—perhaps I should include also those in psychology—will not take it amiss if I include them with us under the good, old-fashioned name of *naturalists*.

The sum and substance of biological inquiry may be embodied in two questions: What is the living organism, and how has it come to be? We often find it convenient to lay the emphasis on one or the other of these questions, but fundamentally they are inseparable. The existing animal bears the indelible impress of its past; the extinct animal can be comprehended only in the light of the present. For instance, the palæontologist is most directly concerned with problems of the past, but at every step he is confronted by phenomena only to be comprehended through the study of organisms as they now are. Our main causal analysis of evolution must be carried out by experimental studies on existing forms. All this seems self-evident, yet the singular fact is that only in more recent years have students of evolution taken its truth fully to heart. And here lies the key to the modern movement in zoology of which I propose to speak.

I do not wish to dwell on matters of ancient history; but permit me a word concerning the conditions under which this movement first began to take definite shape as the nineteenth century drew towards its close. In the first three decades after the "Origin of Species" studies upon existing animals were largely dominated by efforts to reconstruct their history in the past. Many of us will recall with what ardour naturalists of the time threw themselves into this profoundly interesting task. Many of us afterwards turned to work of widely different type; but have our later interests, I wonder, been keener or more spontaneous than those awakened by the morphological-historical problems, some of them already half forgotten, which we then so eagerly tried to follow? I am disposed to doubt it. The enthusiasm of youth? No doubt; but something more, too. Efforts to solve those problems have in the past often failed; they no longer occupy a place of dominating importance; but they will continue so long as biology endures, because they are the offspring of an ineradicable historical instinct, and their achievement stands secure in the great body of solid fact which they have built into the framework of our science. Says Poincaré: "The advance of science is not comparable to the changes of a city, where old edifices are pitilessly torn down to give place to new, but to the continuous evolution of zoologic types which develop ceaselessly and end by becoming unrecognisable to the common sight, but where an expert eye finds always traces of the prior work of the centuries past. One must not think then that the old-fashioned theories have been sterile and vain."

After all, science impresses us by something more than the cold light of her latest facts and formulas. The drama of progress, whether displayed in the evolution of living things or in man's age-long struggle to comprehend the world of which he is a product, stirs the imagination by a warmer appeal. Without it we should miss something that we fain would keep—something, one may suspect, that has played an important part of the higher levels of scientific achievement.

I seem to have been caught unawares in the act of moralising. If so, let it charitably be set down as an attempt to soften the hard fact that thirty years after the "Origin of Species" we found ourselves growing discontented with the existing methods and results of phylogenetic inquiry and with current explanations of evolution and adaptation. Almost as if by a preconcerted plan, naturalists began to turn aside from historical problems in order to learn more of organisms as they now are. They began to ask themselves whether they had not been over-emphasising the problems of evolution at the cost of those presented by life-processes everywhere before our eyes to-day. They awoke to the insufficiency of their traditional methods of observation and comparison and they turned more and more to the method by which all the great conquests of physico-chemical science had been achieved, that which undertakes the analysis of phenomena by deliberate control of the conditions under which they take place—*the method of experiment*. Its steadily increasing importance is the most salient feature of the new zoology.

Experimental work in zoology is as old as zoology itself; nevertheless, the main movement in this direction belongs to the past two decades. I will make no attempt to trace its development; but let me try to suggest somewhat of its character and consequences by a few outlines of what took place in embryology.

The development of the egg has always cast a peculiar spell on the scientific imagination. As we follow it hour by hour in the living object we witness a spectacular exhibition that seems to bring us very close to the secrets of animal life. It awakens an irrepressible desire to look below the surface of the phenomena, to penetrate the mystery of development. The singular fact, nevertheless, is that during the phylogenetic period of embryological research this great problem, though always before our eyes, seemed almost to be forgotten in our pre-occupation with purely historical questions—such as the origin of vertebrates or of annelids, the homologies of germ-layers, gill-slits or nephridia, and a hundred others of the same type. Now, these questions are, and always will, remain of great interest; but embryology, as at last we came to see, is but indirectly connected with historical problems of this type. The embryologist seeks first of all to attain to some understanding of development. It was therefore a notable event when, in the later 'eighties, a small group of embryologists, headed by Wilhelm Roux, turned away from the historical aspects of embryology and addressed themselves to experiments designed solely to throw light upon the mechanism of development. The full significance of this step first came home to us in the early 'nineties with Driesch's memorable discovery that by a simple mechanical operation we can at will cause one egg to produce two, or even more than two, perfect embryos. I will not pause to inquire why this result should have seemed so revolutionary. It was as if the scales had fallen from our eyes. With almost a feeling of shock we took the measure of our ignorance and saw the whole problem of development reopened.

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[2] *Science*, N. S., xiii., No. 314, January 4, 1901.

The immediate and most important result of this was to stimulate a great number of important objective investigations in embryology. But let me pause for a moment to point out that at nearly the same time a similar reawakening of interest in the experimental investigation of problems of the present became evident in many other directions—for example, in studies on growth and regeneration; on cytology and protozoology; on economic biology; on ecology, the behaviour of animals and their reactions to stimuli; on heredity, variation, and selection. The leaven was indeed at work in almost every field of zoology, and everywhere led to like results. It was a day of rapid obliteration of conventional boundary lines; of revolt from speculative systems towards the concrete and empirical methods of the laboratory; of general and far-reaching extension of experimental methods in our science.

But I will return to embryology. It may be doubted whether any period in the long history of this science has been more productive of varied and important discoveries than that which followed upon its adoption of experimental methods. In one direction the embryologist went forward to investigations that brought him into intimate relations with the physicist, the chemist, the pathologist, and even the surgeon. A flood of light was thrown on the phenomena of development by studies on differentiation, regeneration, transplantation, and grafting; on the development of isolated blastomeres and of egg-fragments; on the symmetry and polarity of the egg; on the relations of development to mechanical, physical, and chemical conditions in the environment; on isolated living cells and tissues, cultivated like micro-organisms, outside the body *in vitro*; on fertilisation, artificial parthenogenesis, and the chemical physiology of development. In respect to the extension of our real knowledge these advances constitute an epoch-making gain to biological science. And yet these same researches afford a most interesting demonstration of how the remoter problems of science, like distant mountain-peaks, seem to recede before us even while our actual knowledge is rapidly advancing. Thirty years after Roux's pioneer researches we find ourselves constrained to admit that in spite of all that we have learned of development the egg has not yet yielded up its inmost secrets. I have referred to the admirable discovery of Driesch concerning the artificial production of twins. That brilliant leader of embryological research had in earlier years sought for an understanding of development along the lines of the mechanistic or physico-chemical analysis, assuming the egg to be essentially a physico-chemical machine. He now admitted his failure and, becoming at last convinced that the quest had from the first been hopeless, threw all his energies into an attempt to resuscitate the half-extinct doctrines of vitalism and to found a new philosophy of the organism. Thus the embryologist, starting from a simple laboratory experiment, strayed further and further from his native land until he found himself at last quite outside the pale of science. He did not always return. Instead, he sometimes made himself a new home—upon occasion even established himself in the honoured occupancy of a university chair of philosophy!

The theme that is here suggested tempts me to a digression, because of the clear light in which it displays the attitude of modern biology towards the study of living things. It is impossible not to admire the keenness of analysis, and often the artistic refinement of skill (which so captivates us, for instance, in the work of M. Bergson) with which the neo-vitalistic writers have set forth their views. For my part, I am ready to go further, admitting freely that the position of these writers *may* at bottom be well grounded. At any rate, it is well for us now and then to be rudely shaken out of the ruts of our accustomed modes of thought by a challenge that forces upon us the question whether we really expect our scalpels and microscopes, our salt-solutions, formulas, and tables of statistics, to tell the whole story of living things. It is, of course, impossible for us to assert that they will. And yet the more we ponder the question the stronger grows our conviction that the "entelechies" and such-like agencies conjured forth by modern vitalism are as sterile for science as the final causes of an earlier philosophy; so that Bacon might have said of the former, as he did of the latter, that they are like the Vestal virgins—dedicated to God, and barren. We must not deal too severely with the naturalist who now and then permits himself an hour of dalliance with them. An uneasy conscience will sooner or later drive him back into his own straight and narrow way with the insistent query: The specific vital agents, *sui generis*, that are postulated by the vitalist—are they sober realities? Can the existence of an "élan vital," of "entelechies," of "psychoids," be experimentally verified? Even if beyond the reach of verification may they still be of practical use in our investigations on living things, or find their justification on larger grounds of scientific expediency. However philosophy may answer, science can find but one reply. *The scientific method is the mechanistic method.* The moment we swerve from it by a single step we set foot in a foreign land where a different idiom from ours is spoken. We have, it is true, no proof whatever of its final validity. We do not adopt the mechanistic view of organic nature as a dogma but only as a practical programme of work, neither more nor less. We know full well that our present mechanistic conceptions of animals and plants have not yet made any approach to a complete solution of the problems of life, whether past or present. This should encourage us to fresh efforts, for just in the present inadequacy of these conceptions lies the assurance of our future progress. But the way of unverifiable (and irrefutable) imaginative constructions is not our way. We must hold fast to the method by which all the great advances in our knowledge of nature have been achieved. We shall make lasting progress only by plodding along the old, hard beaten trail blazed by our scientific fathers—the way of observation, comparison, experiment, analysis, synthesis, prediction, verification. If this seems a prosaic programme we may learn otherwise from great discoverers in every field of science who have demonstrated how free is the play that it gives to the constructive imagination and even to the faculty of artistic creation.

II.

Thus far I have desired to emphasise especially the reawakening of our interest in problems of the present, and the growing importance of experimental methods in our science. It is interesting to observe how these changes have affected our attitude towards the historical problem as displayed in the modern study of genetics. Even here we are struck by the same shifting of the centre of gravity that has been remarked in other fields of inquiry. In the Darwinian era studies on variation and heredity seemed significant mainly as a means of approach to the problems of evolution. The post-Darwinians awoke once more to the profound interest that lies in the genetic composition and capacities of living things as they now are. They turned aside from general theories of evolution and their deductive application to special problems of descent in order to take up objective experiments on variation and heredity for their own sake. This was not due to any doubts concerning the reality of evolution or to any lack of interest in its problems. It was a policy of masterly inactivity deliberately adopted; for further discussion concerning the causes of evolution had clearly become futile until a more adequate and critical view of existing genetic phenomena had been gained. Investigators in genetics here followed precisely the same impulse that had actuated the embryologists; and they, too, reaped a rich harvest of new discoveries. Foremost among them stands the re-discovery of Mendel's long-forgotten law of heredity—a biological achievement of the first rank which in the year 1900 suddenly illuminated the obscurity in which students of heredity had been groping. Another towering landmark of progress is De Vries's great work on the mutation theory, published a year later, which marked almost as great a transformation in our views of variation and displayed the whole evolution problem in a new light. In the era that followed, the study of heredity quickly became not only an experimental, but almost an exact science, fairly comparable to chemistry in its systematic employment of qualitative and quantitative analysis, synthesis, prediction, and verification. More and more clearly it became evident that the phenomena of heredity are manifestations of definite mechanism in the living body. Microscopical studies on the germ-cells made known an important part of this mechanism and provided us with a simple mechanical explanation of Mendel's law. And suddenly, in the midst of all this, by a kaleidoscopic turn, the fundamental problem of organic evolution crystallises before our eyes into a new form that seems to turn all our previous conceptions topsy-turvy.

I will comment briefly on this latest view of evolution, partly because of its inherent interest, but also because it again exemplifies, as in the case of embryology, that temptation to wander off into metaphysics (*sit venia verbo!*) which seems so often to be engendered by new and telling discoveries in science. The fundamental question which it raises shows an interesting analogy to that encountered in the study of embryology, and may conveniently be approached from this side.

To judge by its external aspects, individual employment, like evolution, would seem to proceed from the simple to the complex; but is this true when we consider its inner or essential nature? The egg *appears* to the eye far simpler than the adult; yet genetic experiment seems continually to accumulate evidence that for each independent hereditary trait of the adult the egg contains a corresponding *something* (we know not what) that grows, divides, and is transmitted by cell-division without loss of its specific character and independently of other somethings of like order. Thus arises what I will call the puzzle of the microcosm. Is the appearance of simplicity in the egg illusory? Is the hen's egg fundamentally as complex as the hen, and is development merely the transformation of one kind of complexity into another? Such is the ultimate question of ontogeny, which in one form or another has been debated by embryologists for more than two centuries. We still cannot answer it. If we attempt to do so, each replies according to the dictates of his individual temperament—that is to say, he resorts to some kind of symbolism; and he still remains free to choose that particular form which he finds most convenient, provided it does not stand in the way of practical efforts to advance our real knowledge through observation and experiment. Those who must have everything reduced to hard and fast formulas will no doubt find this rather disconcerting; but worse is to follow. Genetic research now confronts us with essentially the same question as applied to the evolutionary germ. The puzzle of the microcosm has become that of the macrocosm. Were the primitive forms of life really simpler than their apparently more complex descendants? Has organic evolution been from the simple to the complex, or only from one kind of complexity to another? May it even have been from the complex to the simple by successive losses of inhibiting factors which, as they disappear, set free qualities previously held in check? The last of these is the startling question that the president of the British Association propounds in his recent brilliant address at Melbourne, asking us seriously to open our minds to the inquiry: "Whether evolution can at all reasonably be represented as an unpacking of an original complex which contained within itself the whole range of complexity which living things exhibit?" This conception, manifestly, is nearly akin to the theory of pangenesis and individual development, as elaborated especially by De Vries and by Weismann. It inevitably recalls also, if less directly, Bonnet's vision of "palingenesis," which dates from the eighteenth century.

We should be grateful to those who help us to open our minds; and Prof. Bateson, as is his wont, performs this difficult operation in so large and masterly a fashion as to command our lively admiration. It must be said of his picturesque and vigorous discussion that we are kept guessing how far we are expected to take it seriously, or at least literally. We have always a lurking suspicion that possibly his main purpose may, after all, be to remind us, by an object-lesson, how far we still are from comprehending the nature and causes of evolution, and this suspicion is strengthened by the explicit statement in a subsequent address, delivered at Sydney, that our knowledge of the nature of life is "altogether too slender to warrant speculation on these fundamental questions." Let us, however, assume that we are seriously asked to go further and to enter the *cul de sac* that Prof. Bateson so invitingly places in our way. Once within it, evidently we are stalemated in respect to the origin and early history of life; but as to that, one form of total ignorance is perhaps as good as another, and we can still work out how the game has been played, even though we can never find out how the pieces were set up. But has the day so soon arrived when we must resign ourselves to such an ending? Are we prepared to stake so much upon the correctness of a single hypothesis of allelomorphism and dominance? This hypothesis—that of "presence and absence"—has undoubtedly been a potent instrument of investigation; but there are some competent students of genetics who seem to find it equally simple to formulate and analyse the phenomena by the use of a quite different hypothesis, and one that involves no such paradoxical consequences in respect to the nature of evolution. Are we not then invited to strain at a gnat and to swallow a camel?

But I pass over the technical basis of the conception in order to look more broadly at its theoretic superstructure. Is not this, once again, a kind of symbolism by which the endeavour is made to deal with a problem that is for the present out of our reach? Neither you nor I, I dare say, will hesitate to maintain that the primordial Amœba, if we may so dub the earliest of our ancestors) embodied in some sense or other all the potentialities, for better or for worse, that are realised before us at this moment in the American Association for the Advancement of Science. But if we ask ourselves exactly what we mean by this we discover our total inability to answer in more intelligible terms. We cannot, it is true, even if we would, conquer the temptation now and then to spread the wings of our imagination in the thin atmosphere of these upper regions; and this is no doubt an excellent tonic for the cerebrum provided we cherish no illusions as to what we are about. No embryologist, for example, can help puzzling over what I have called the problem of the microcosm; but he should be perfectly well aware that in striving to picture to his imagination the ultimate organisation of the egg, of the embryological germ, that is actually in his hands for observation and experiment, he is perilously near to the habitat of the mystic and the transcendentalist. The student of evolution is far over the frontier of that forbidden land, in any present attack upon the corresponding problem of the macrocosm; for the primordial Amœba, the evolutionary germ, is inconceivably far out of our reach, hidden behind the veil of a past the beginnings of which lie wholly beyond our ken. And why, after all, should we as yet attempt the exploration of a region which still remains so barren and remote? Surely not for the lack of accessible fields of genetic research that are fertile and varied enough to reward our best efforts, as no one has more forcibly urged or more brilliantly demonstrated by his own example than Prof. Bateson himself.

Perhaps it would be the part of discretion to go no further. But the remarkable questions that Prof. Bateson has raised concerning the nature of evolution leave almost untouched the equally momentous problem as to what has guided its actual course. In approaching my close I shall be bold enough to venture a step in this direction, even one that will bring us upon the hazardous ground of organic adaptations and the theory of natural selection. I need not say that this subject is beset by intricate and baffling difficulties which have made it a veritable bone of contention among naturalists in recent years. In our attempts to meet them we have gone to some curious extremes. On the one hand, some naturalists have in effect abandoned the problem, cutting the Gordian knot with the conclusion that the power of adaptation is something given with organisation itself and as such offers a riddle that is for the present insoluble. In another direction we find attempts to take the problem in flank, to restate it, to ignore it—sometimes, it would almost seem to argue it out of existence. It has been urged in a recent valuable work—by an author, I hasten to say, who fully accepts both the mechanistic philosophy and the principle of selection—that fitness is a reciprocal relation, involving the environment no less than the organism. This is both a true and a suggestive thought; but does it not leave the naturalist floundering amid the same old quicksands? The historical problem with which he has to deal must be grappled at closer quarters. He is everywhere confronted with specific devices in the organism that must have arisen long after the conditions of environment to which they adjusted. Animals that live in water are provided with gills. Were this all we could probably muddle along with the notion that gills are no more than lucky accidents. But we encounter a sticking point in the fact that gills are so often accompanied by a variety of ingenious devices, such as reservoirs, tubes, valves, pumps, strainers, scrubbing brushes, and the like, that are obviously tributary to the main function of breathing. Given water, asks the naturalist, how has all this come into existence and been perfected? The question is an inevitable product of our common sense. The metaphysician, I think, is not he who asks but he who would suppress it.

For all that it would seem that some persons find the very word adaptation of too questionable a reputation for mention in polite scientific society. Allow me to illustrate by a leaf taken from my own notebook. I once ventured to publish a small experimental work on the movements of the fresh-water Hydra with respect to light. What was my surprise to receive a reproof from a friendly critic, because I had not been content with an objective description of the movements but had also been so indiscreet as to emphasise their evident utility to the animal. I was no doubt too young then—I fear I am too old now—to comprehend in what respect I had sinned against the light. That was long ago. I will cite a more recent example from a public discussion on adaptation that took place before the American Society of Naturalists a year or two since. "The dominance of the concept of adaptation," said one naturalist, "which now distinguishes our science from the non-biological ones, is related to the comparatively youthful stage of development so far attained by biology, and *not to any observed character in the living objects with which we deal.*" Here, we almost seem to catch an echo from the utterances of a certain sect of self-styled "scientists" who love to please themselves with the quaint fancy that physical disease is but one of the "errors of mortal mind."

Now, it is undoubtedly true that many adaptations, to cite Prof. Bateson once more, are "not in practice a very close fit." Even the eye, as Helmholtz long ago taught us, has some defects as an optical instrument; nevertheless, it enables us to see well enough to discern some food for reflection concerning adaptations among living things. And it is my impression that efforts to explain adaptations are likely to continue for the reason that naturalists as a body, perhaps influenced by Huxley's definition of science, have an obstinate habit of clinging to their common sense.

At the present day there is no longer the smallest doubt of the great outstanding fact that many complex structural adaptations—it would probably be correct to say all such—have not come into existence at a single stroke but have moved forward step by step to the attainment of their full degree of perfection. What has dominated the direction and final outcome of such advancing lines? We cannot yet answer this question with any degree of assurance; but procrastinate as we may, it must in the end squarely be faced. We have seen one theory after another forced back within narrower lines or crumbling away before the adverse fire of criticism. I will not pause to recount the heavy losses that must be placed to the account of sexual selection, of neo-Lamarckism, of orthogenesis. Some naturalists, no doubt, would assign a prominent place in this list of casualties to natural selection; but probably there are none who would hold that it has been destroyed utterly. The crux lies in the degree of its efficacy. Stated as an irreducible minimum the survival of the fit is an evident fact. Individuals that are unfitted to live, or to reproduce, leave few or no descendants—so much, at least, must be admitted by all. But does this colourless and trite conclusion end the matter or adequately place before us the significance of the facts? Just here lies the whole issue. Does destruction of the unfit accomplish no other result than to maintain the *status quo*, or has it conditioned the direction of progress? Accepting the second of these alternatives, Darwin went so far as to assign to it a leading rôle among the conditions to which the living world owes its existing configuration. Since his time the aspect of the problem has widely changed. We must rule out the question of the origin of neutral or useless traits. We must not confuse the evolution of adaptations with the origin of species. We must bear in mind the fact that Darwin often failed to distinguish between non-heritable fluctuations and hereditary mutations of small degree. We are now aware that many apparently new variations may be no more than recombination-products of pre-existing elements, We should, no doubt, make a larger allowance for the rôle of single "lucky accidents" in evolution than did many of the earlier evolutionists. And yet, so far as the essence of the principle is concerned, I am bound to make confession of my doubts whether any existing discussion of this problem affords more food for reflection, even to-day, than that contained in the sixth and seventh chapters of the "Origin of Species" and elsewhere in the works of Darwin.

Undeniably there is a large measure of truth in the contention that natural selection still belongs rather to the philosophy than to the science of biology. In spite of many important experimental and critical studies on the subject Darwin's conception still remains to-day in the main what it was in his own time, a theory, a logical construction, based, it is true, on a multitude of facts, yet still awaiting adequate experimental test. Simple though the principle is, its actual effect in nature is determined by conditions that are too intricate and operate through periods too great to be duplicated in the experimental laboratory. Hence it is that even after more than fifty years of Darwinism the time has not yet come for a true estimate of Darwin's proposed solution of the great problem.

But there is still another word to be said. Too often in the past the facile formulas of natural selection have been made use of to carry us lightly over the surface of unsuspected depths that would richly have repaid serious exploration. In a healthy reaction from this purblind course we have made it the mode to minimise Darwin's theory; and no doubt a great service has been rendered to our study of this problem by the critical and sceptical spirit of modern experimental science. But there is a homely German saying that impresses upon us the need of caution as we empty out the bath lest we pour out the child too. This suggests that we should take heed how we under-estimate the one really simple and intelligible explanation of organic adaptations that has thus far been placed in our hands. And in some minds—if I include my own among them let it be set down to that indiscretion at which I have hinted—the impression grows that our preoccupation with the problem as it appears at short focus may in some measure have dimmed our vision of larger outlines that must be viewed at longer range; that we may have emphasised minor difficulties at the cost of a larger truth. To such minds it will seem that the principle of natural selection, while it may not provide a master key to all the riddles of evolution, still looms up as one of the great contributions of modern science to our understanding of nature.

I have taken but a passing glance at a vast and many-sided subject. I have tried to suggest that the tide of speculation in our science has far receded; that experimental methods have taken their rightful place of importance; that we have attained to a truer perspective of past and present in our study of the problems of animal life. The destructive phase through which we have passed has thoroughly cleared the ground for the new constructive era on which we now have entered. All the signs of the times indicate that this era will long endure. And this is of good augury for a future of productive effort, guided by the methods of physico-chemical science, impatient of merely *a priori* constructions, of academic discussions, of hypotheses that cannot be brought to the test of experimental verification. The work ahead will make exacting technical demands upon us. The pioneer days of zoology are past. The naturalist of the future must be thoroughly trained in the methods and results of chemistry and physics. He must prepare himself for a life of intensive research, of high specialisation; but in the future even more than in the past he will wander in vain amid the dry sands of special detail if the larger problems and general aims of his science be not held steadfastly in view. For these are the outstanding beacon lights of progress; and while science viewed at close range seems always to grow more complex, a wider vision shows that her signal discoveries are often singularly simple. This perhaps may help us to keep alive the spirit of the pioneers who led the advances of a simpler age; and it is full of hope for the future.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The Huxley Lecture will be delivered on January 21 by M. Emile Verhaeren (the national poet of Belgium), who has chosen as his subject "L'Esprit Belge."

LONDON.—Among the opening lectures in the Lent Term at the Bedford College for Women are several which are open free to the public without ticket. In the department of geology a series of four lectures on minerals used as gem stones will be given on Thursdays at 5.15 p.m., beginning on January 28, by Dr. A. Hutchinson and Dr. H. H. Thomas. In the botany department Mr. W. Neilson Jones will lecture on Mondays at 5 p.m., beginning on January 18, on phenomena of heredity. There will also be lectures on hygiene, mathematics, physiology, and chemistry.

A COURSE of lectures to the University of London Officers Training Corps on military subjects is being given by the members of the staff of Birkbeck College, London, on Tuesdays, at 8 p.m. The first lecture, on the economics of war, was given on January 19 by the principal of the college, Dr. G. Armitage-Smith. Forthcoming lectures on succeeding Tuesdays are as follows:—"Bacteria," Dr. H. C. I. Gwynne-Vaughan; "Some Past Fights for Freedom," Mr. L. Ricci; "Trench Making," Dr. J. W. Evans; "Report Writing," Mr. J. H. Lobban; "International Law of War on Land," Mr. G. C. Rankin; "Map Making and Map Reading," Dr. J. F. Unstead; "Range Finding," Dr. A. Griffiths; "Explosives," Dr. G. Senter; "War Clouds of Modern Europe," Mr. A. Jones; "An Ancient Drill Book," Mr. F. A. Wright. The lectures are intended primarily for cadets of the Officers Training Corps, but are open to all persons interested, without fee.

A COPY of the "General Information Number" of the Bulletin of the Armour Institute of Technology has been received from Chicago. Full particulars are given of the courses offered in mechanical, electrical, civil, chemical, and fire protection engineering, as well as those in architecture and the industrial arts. Each of these four-year courses represents a carefully balanced group system of studies, combining a thorough and broad scientific training with the elements of liberal culture, and all lead to the degree of bachelor of science.

THE president, vice-president, and council of the Royal College of Surgeons in Ireland have decided to place in the college a permanent record of the names of all the students, licentiates, and fellows of the college who are at present serving with his Majesty's Navy and Expeditionary Forces, and further to erect a suitable memorial to all such as fall in the war. The president, vice-president, and council will be glad if the relatives and friends would communicate the names of such students, licentiates, and fellows to the registrar of the college.

IN an article in *Science* for December 25, Mr. John C. Burg, of North-Western University, Chicago, examines and summarises the registration statistics for November 1, 1914, of some thirty universities in the United States. The largest gains for the year in the number of students were as follows:—Columbia, 1365; California, 1109; Pittsburgh, 1069; Ohio State, 832; Wisconsin, 806; Harvard, 784; New York, 634; Minnesota, 552; Pennsylvania, 536. The eight universities with the largest total number of students are given in the article as:—Columbia, 11,294; California, 8180; Chicago, 7131; Wisconsin, 6696; Pennsylvania, 6505; Harvard, 6411; Michigan, 6319; New York University, 6142. In the scientific schools, that is, including the schools of mines, engineering, chemistry, and related subjects, Illinois takes the lead with 1406 students, followed by Cornell, 1363, Michigan, 1347, Yale, 1056, Pennsylvania, 906, Ohio State, 851, Wisconsin, 796, and California, 763.

IT is announced in the issue of *Science* for January 8 that the sum of 486,000*l.* was obtained for Wellesley College in the fourteen months ended in December, 1914, according to a statement given out by the treasurer. Of this amount 86,000*l.*, including a conditional pledge of 40,000*l.* from the General Educational Board, was raised before the fire of March 17, when College Hall was burned. The remaining 400,000*l.* includes a pledge from the Rockefeller Foundation of 150,000*l.* Only three gifts of more than 2000*l.* were received since last August. One of these was a gift from Mr. Carnegie of 19,000*l.* for the enlargement of the library. From the same source we learn that the Massachusetts Institute of Technology received in gifts during the past year the sum of 80,000*l.*, besides two items wherein the institute is residuary legatee, and the amounts have not been determined. Among the gifts may be mentioned: bequest of Caroline L. W. French (outright), 20,000*l.*; (residue), 20,000*l.*; Lucius Tuttle, 10,000*l.*; and Nathaniel Thayer, 10,000*l.*

THE issue for January of the Technical Journal of the Association of Teachers in Technical Institutions contains an interesting article on the Massachusetts Institute of Technology. This article is written by Dr. Tyler, Walker professor of mathematics, and Mr. R. C. Maclaurin, president of the college. It may be noted that not only is admission to the college regulated by means of entrance examinations, but there is a continual weeding out of those students who do not display the requisite ability and application. New students are examined periodically, and if their work proves to be unsatisfactory they are required to withdraw. Some of our own colleges could copy this system, and thereby show a considerable improvement in their produce. In the same journal there is an article on laboratories for building trade students, by Mr. G. Arnall. This article suggests that the time is ripe for the institution of separate laboratories for such students, in which the testing of cements, timber, ferro-concrete, etc., could be studied practically. The scheme will probably involve considerable modification of building courses, and the author invites his colleagues in this branch of teaching to submit model syllabuses of laboratory experiments.

IN Circular 885, issued on January 11, the Board of Education states that there is likely to be some difficulty in procuring in this country adequate supplies of chemical laboratory glassware. These articles have ordinarily been imported from Germany and Austria, and they have not hitherto been manufactured in this country except in negligible quantities. Steps to ensure the production of chemical glassware in this country are being taken, but in view of the technical and other difficulties which have to be overcome it must necessarily be some considerable time before there can be production on a large and sufficient scale. Having regard to the extent to which many of the manufacturing industries of the country, including some of special value at the present crisis, require chemical glassware for analytical and other purposes connected with the various industrial processes, it is important that every effort should be made to economise in the use of stocks of such ware now in the hands of educational establishments. These stocks should be examined and a careful record kept of quantities and consumption. Every effort should be made to avoid breakages, and it will probably be found possible to economise in the consumption of "Jena" vessels by the substitution in certain cases of other kinds of glass receptacles. Fresh orders should not be given to manufacturers or supplying agencies for the present, where this can possibly be avoided. The Board of Education is confident that local education authorities and schools and colleges will do their best to assist the Government in the matter.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, January 14.—Sir Joseph Larmor, president, and afterwards Prof. A. E. H. Love, vice-president, in the chair.—Prof. H. M. **Macdonald**: A class of diffraction problems.—H. E. J. **Curzon**: Halphen's transformation.—Dr. A. **Young**: A Christmas problem in probabilities.—W. E. H. **Berwick**: The condition that a quintic equation should be soluble by radicles.—Sir J. **Larmor**: The variation of the earth's angular velocity of rotation.

PARIS.

Academy of Sciences, January 4.—M. A. Perrier in the chair.—G. **Bigourdan**: The rapid testing of small telescopes. The method proposed, which is easily and rapidly carried out, is a relative one, comparison being made with a standard telescope. The instrument is focussed on a square, one centimetre in the side, containing a group of black lines ruled at equal distances. The number of lines in the centimetre varies from 4 to 20, and the white interspaces are equal in width to the black lines. Details of the mode of testing separating power, astigmatism and field are given.—L. **Landouzy**: a flexible and non-inflammable gelatine film, suitable for radiology. A description of the preparation and use of thin gelatine plates designed to replace the ordinary glass-coated plates. The unexposed plates, with cardboard supporting frame, weigh 8 per cent. of the weight of the ordinary plate, and after exposure and removal of the film from the frame, this is reduced to 2·8 per cent. Additional advantages as compared with glass plates are cheapness, non-fragility, flexibility, enabling the plate to be inserted into awkward positions without damage, and as compared with celluloid, non-inflammability and perfection of detail.—Edouard **Heckel**: *Solanum*

Caldasii and the cultural bud mutation of its subterranean parts. This variety has received several names, and in the author's opinion the classification is too artificial. Proofs are given of the mutation of this wild potato.—MM. **Camichel, Eydoux,** and **Lhériaud**: The Venturi meter. A discussion of the accuracy of the Venturi water meter. The theoretical formula is $q=\lambda a\sqrt{p_1-p_2}$, in which q is the quantity, (p_1-p_2) the difference of pressure between the main tube and the construction, and λ a factor less than unity depending on the internal friction of the liquid. Experimental results with a Venturi gauge of 300 mm. diameter, contraction $\frac{1}{4}$, and flow varying from 60 to 160 litres a second. The value of λ was found to be 1, the error of experiment being under 1 per cent. Similar results were obtained with a larger instrument, passing 800 to 3000 litres a second.—Emile **Saillard**: The estimation of saccharose in beet molasses. Inversion method with double neutral polarisation. The method proposed eliminates errors due to the action of alkaline salts upon saccharose and on invert sugar, and also errors caused by the products of the action of alkaline salts upon active nitrogen compounds present in the beet molasses.—N. **Arabu**: Studies on the Tertiary formation of the basin of the Sea of Marmora. The Vindobonian stage of Troade.—J. de **Rey-Pailhade**: The existence of philothion in the crystalline lens of the eyes of animals. Philothion is a special albumen, characterised by the existence in its molecule of labile hydrogen capable of combining with free sulphur at a temperature of 40° C., with production of sulphuretted hydrogen.—M. **Tiffeneau**: The destination of chloralose in the organism and its relations with glycuronic compounds. In the dog, chloralose is eliminated in part unchanged, and partly in the form of a new acid, chloralose-glycuronic acid. Chloralose does not give rise to chloral and glucose in the organism, and its physiological effects are not due to the chloral it contains.

NEW SOUTH WALES.

Linnean Society, November 25, 1914.—Mr. W. S. Dun, president, in the chair.—A. M. **Lea**: Descriptions of new species of Australian Coleoptera. Part x. Three genera and forty-eight species (families Lucanidæ, Malacodermidæ, Curculionidæ, and Chrysomelidæ) are described as new.—C. **Hedley**: Studies on Australian Mollusca. Part xii. This paper continues the subject of previous communications, and embraces notes gathered abroad in the British and other museums. The Australian species formerly grouped under Voluta are enumerated, revised, and arranged in modern genera. A partial revision of Thais and Zafra is attempted, and various critical species of Arcularia, Montfortia, Tallorbis, and Acmæa are discussed.—L. A. **Cotton**: The diamond-deposits of Copeton, New South Wales. A description of the variations in the Tertiary stream-deposits is given, together with the relations of these to the distribution of the diamonds. The investigation has made clear the relations of the various parts of the Tertiary leads, and, incidentally, has suggested an interesting physiographical feature. It is pointed out that it is highly probable that the Gwydir and Macintyre Rivers of Tertiary times originally formed one stream uniting a little to the west of Inverell. An important discovery was made by Mr. A. R. Pike, in 1904, which has a significant bearing on the origin of the diamond. This was the finding of a diamond in a matrix of dolerite. Later investigation has indicated that it is probable that most, if not all, the diamonds in the field have been derived from this type of rock.—Dr. R. **Greig-Smith**: Contributions to a knowledge of soil-fertility. No. xii.—The action of toluene upon the soil-protozoa. The action of toluene upon the protozoa of the soil depends upon the moisture-content. When less than one-tenth of the water-holding capacity of the soil is present, certain members of the Ciliates, Amœbæ and Flagellates may not be destroyed when amounts up to 20 per cent. of toluene are added to the soil. If more than one-tenth of the water-holding capacity is present, the Ciliates are destroyed by 1 per cent. or 2 per cent. of toluene, while the action upon the Amœbæ and Flagellates is irregular. Conditions which destroy the sulphur-oxidising bacteria, also destroy the Ciliates.—Rev. W. W. **Watts**: Some notes on the ferns of North Queensland. These notes are the result of a trip through the Cairns district, as far south as Bartle Frere and the Russell River, and as far west as the Tully Falls.—Archdeacon F. E. **Haviland**: The pollination of *Goodenia cycloptera*, R. Br. *G. cycloptera*, R. Br., is a decumbent species, in this State, generally restricted to the western plains. The process of pollination, as the result of three years' observation, is described.—A. F. Basset **Hull**: A collection of fossil Polyplacophora from N.W. Tasmania, with descriptions of three new species. In addition to valves of *Lorica duniana*, Hull, and *Chiton fossinus*, Ashby and Torr, the collection studied comprised the remains of three strongly marked species of Loricella, hitherto undescribed. The fossils are from the well-known beds between Wynyard and Table Cape.

BOOKS RECEIVED.

Scottish National Antarctic Expedition. *Scotia* Collection of Atlantic Fishes. By R. S. Clark. Pp. 379–401+2 maps. (Edinburgh: Scottish Oceanographical Laboratory.) 1*s.* 3*d.*

Scottish National Antarctic Expedition. The Whale Fisheries of the Falkland Islands and Dependencies. By T. E. Salvesen. Pp. 479–486+10 plates and text map. (Edinburgh: Scottish Oceanographical Laboratory.) 3*s.*

Ordnance Survey. Professional Papers. New series. No. 3. Notes on the Geodesy of the British Isles. By Col. C. F. Close. Pp. 33. (London: H.M.S.O.; Wyman and Sons, Ltd.) 1*s.* 6*d.*

Willing's Press Guide. Forty-second year. Pp. 470. (London: J. Willing, Ltd.) 1*s.*

A Treatise on the Analytic Geometry of Three Dimensions. By Dr. G. Salmon. Edited by R. A. P. Rogers. Fifth edition. Vol. ii. Pp. xvi+334. (London: Longmans and Co.; Dublin: Hodges, Figgis and Co., Ltd.) 7*s.* 6*d.* net.

War Map of Central Europe, after B. V. Darbishire's Wall Map. (Oxford University Press.) 3*d.* net.

The Teaching of Algebra (including Trigonometry). By Prof. T. P. Nunn. Pp. xiv+616. (London: Longmans and Co.) 7*s.* 6*d.*

Exercises in Algebra (including Trigonometry). By Prof. T. P. Nunn. Part 1. Pp. x+356+Answers, pp. 357–421. Part 2. Pp. xi+514+Answers, pp. 515–551. (London: Longmans and Co.) 4*s.* and 6*s.* 6*d.* respectively.

Artificial Waterways of the World. By A. B. Hepburn. Pp. xi+171. (London: Macmillan and Co., Ltd.) 5*s.* 6*d.* net.

An Introduction to Field Archæology as Illustrated by Hampshire. By Dr. J. P. Williams-Freeman. Pp. xxii+462. (London: Macmillan and Co., Ltd.) 15*s.* net.

Carnegie Endowment for International Peace. Year Book for 1913–14. Pp. xviii+203. (Washington, D.C.)

How Belgium Saved Europe. By Dr. C. Sarolea. Pp. x+226. (London: W. Heinemann.) 2*s.* net.

The Laws of Algebra. By A. G. Cracknell. Pp. vi+68. (London: University Tutorial Press, Ltd.) 1s.

The Substance of Faith Allied with Science. By Sir Oliver Lodge. Cheap edition. Pp. xii+135. (London: Methuen and Co., Ltd.) 1s. net.

Bacon's 6*d*. Contour Atlas. South Scotland edition. (London: G. W. Bacon and Co., Ltd.) 6*d*. net.

A Manual of Chemistry, Theoretical and Practical, Inorganic and Organic. By Dr. A. P. Luff and H. C. H. Candy. Fifth edition. Pp. xix+660. (London: Cassell and Co., Ltd.) 8*s*. 6*d*. net.

Proceedings of the London Mathematical Society. Second series. Vol. xiii. Pp. liii+500. (London: F. Hodgson.) 25*s*.

Mutual Aid: a Factor of Evolution. By P. Kropotkin. Popular edition. Pp. x+240. (London: W. Heinemann.) 1*s*. net.

Annuaire pour l'an 1915. Publié par le Bureau des Longitudes. (Paris: Gauthier-Villars et Cie.)

Workshop Arithmetic. By F. Castle. Pp. viii+172. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Plane Trigonometry. By Prof. H. S. Carslaw. New edition. Pp. xviii+293+Answers, pp. xi. (London: Macmillan and Co., Ltd.) 4*s*. 6*d*.

Solutions to the Questions in Plane Trigonometry. By Prof. H. S. Carslaw. Pp. 179. (London: Macmillan and Co., Ltd.) 6*s*. 6*d*. net.

The Home of the Blizzard: being the Story of the Australasian Antarctic Expedition, 1911–14. By Sir D. Mawson. Vol. i. Pp. xxx+349. Vol. ii. Pp. xiii+338. (London: W. Heinemann.) Two vols., 36*s*. net.

Wild Life Conservation in Theory and Practice. By Dr. W. T. Hornaday. With a chapter on Private Game Preserves, by F. C. Walcott. Pp. vi+240. (New Haven, Conn.: Yale University Press; Oxford University Press.) 6*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 21.

ROYAL SOCIETY, at 4.30.—Atmospheric Electricity Potential Gradient at Kew Observatory, 1898–1912: Dr. C. Chree.—The Transmission of Electric Waves over the Surface of the Earth: Prof. A. E. H. Love.—Electromagnetic Waves in a Perfectly Conducting Tube: L. Silberstein. An Electrically-heated Full Radiator: H. B. Keene.

ROYAL INSTITUTION, at 3.—Modern Theories and Methods in Medicine: H. G. Plimmer.

ROYAL SOCIETY OF ARTS, at 4.30.—Nepal: H. J. Elwes.

LINNEAN SOCIETY, at 5.—Report on the Fishes Collected by Mr. Cyril Crossland in the Sudan: Miss Ruth C. Bamber.—Narrative of his Recent Visit to the Houtman Abrolhos Archipelago, West Australia: Prof. W. J. Dakin.

INSTITUTION OF MINING AND METALLURGY, at 8.—Inflammable Natural Gas as an Economic Mineral: J. A. Leo Henderson and W. H. Henderson.—Investigations in Ore Milling to ascertain the Heat Developed in Crushing: J. Cook.

FRIDAY, JANUARY 22.

ROYAL INSTITUTION, at 9.—Problems of Hydrogen and the Rare Gases: Sir J. Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Standardisation of Pipe Flanges and Flanged Fittings: J. Dewrance.

PHYSICAL SOCIETY, at 5.—Practical Harmonic Analysis: Dr. A. Russell.—Measuring the Focal Length of a Photographic Lens: T. Smith.

SATURDAY. JANUARY 23.

ROYAL INSTITUTION, at 3.—Aerial Navigation—Scientific Principles: Dr. R. T. Glazebrook.

MONDAY, JANUARY 25.

ROYAL SOCIETY OF ARTS, at 8.—Oils, their Production and Manufacture: Dr. F. Mollwo Perkin.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Historical and Physica Geography of the Theatres of War: Dr. Vaughan Cornish.

INSTITUTE OF ACTUARIES, at 5.—The Analysis of Life Office Expenses: C. H. Maltby.

TUESDAY, JANUARY 26.

ROYAL INSTITUTION, at 3.—Muscle in the Service of Nerve: Prof. C. S. Sherrington.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—President's Address: The Slav and Allied Racial Elements in the Peoples of Western Europe: Dr. A. Keith.

ROYAL SOCIETY OF ARTS, at 4.30.—The Economic Development of British East Africa and Uganda: Major E. H. M. Leggett.

WIRELESS SOCIETY, at 8.—Presidential Address: Some Electrical Phenomena: A. A. Campbell Swinton.

MINERALOGICAL SOCIETY, at 5.30.—Note on the Colour of some Alluvial Diamonds and Pyrrhotite: F. P. Mennell.—(1) Crystals of Calomel from Spain: (2) General Formula for the Birefringence of a Crystalplate in terms of the Angles which its normal makes with the Optical Principal Axes: (3) A Numerical Relation of the Sum of the Symmetry-axes situated in the Symmetry-planes of a Polyhedron: Prof. G. Cesàro.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion:* The Lateral Pressure and Resistance of Clay, and the Supporting Power of Clay Foundations: A. L. Bell.—*Paper:* Engineering Operations for the Prevention of Malaria: F. D. Evans.

WEDNESDAY, JANUARY 27.

ROYAL SOCIETY OF ARTS, at 8.—Portrait Painting: the Technique of the Great Masters: Hon. John Collier.

THURSDAY, JANUARY 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Influence of Salt-concentration on Hæmolysis: W. W. C. Topley.—The Life-cycle of Cladocera, with Remarks on the Physiology of Growth and Reproduction in Crustacea: G. Smith.—Investigations on Protozoa in relation to the Factor limiting Bacterial Activity in Soil: T. Goody.—On the Mesodermic Origin and the Fate of the so-called Mesectoderm in Petromyzon: S. Hatta.—The Influence of Direction of Homodromous and Heterodromous Electric Currents on Transmission of Excitation in Plant and Animal: Prof. J. C. Bose.

ROYAL INSTITUTION, at 3.—Modern Theories and Methods in Medicine—Immunity: H. G. Plimmer.

INSTITUTION OF ELECTRICAL ENGINEERS at 8.—The Sixth Kelvin Lecture. Lord Kelvin's Work on Gyrostatics: Prof. A. Gray.

FRIDAY, JANUARY 29.

ROYAL INSTITUTION, at 9.—Gaseous Explosions: Dr. Dugald Clerk.

SATURDAY, JANUARY 30.

ROYAL INSTITUTION, at 3.—Aerial Navigation—Scientific Principles: Dr. R. T. Glazebrook.

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THURSDAY, JANUARY 28, 1915.

A TREATISE ON USEFUL MINERALS AND ROCKS.

The Deposits of the Useful Minerals and Rocks, their Origin, Form, and Content. By Prof. Dr. F. Beyschlag, Prof. J. H. L. Vogt, Prof. D. P. Krusch. Translated by S. J. Truscott. Vol. i. Pp. xxviii + 514. (London: Macmillan and Co., Ltd., 1914.) Price 18*s*. net.

THIS book is the English version of the first volume of a comprehensive treatise on useful minerals and rocks by three authors who are collectively well qualified to deal with the subject, both from the scientific and the economic points of view. The work, when complete, will consist of three volumes, two of which, dealing with ore-deposits, have already appeared in German. Its main object is to explain and illustrate by descriptions of individual occurrences the general principles governing the nature and mode of occurrence of the deposits. The authors emphasise the fact, now generally recognised, that a knowledge of the causes which have resulted in the formation and deformation of these deposits is of value to all persons who are engaged in exploiting the mineral resources of the world. Their point of view is thoroughly scientific, and the classification which they adopt is, therefore, primarily based on genetic principles.

Ore deposits are divided into two great groups, to which the terms syngenetic and epigenetic are applied; those of the former originate at the same time as the country rock, those of the latter have been brought into the positions which they now occupy after the country rock had been produced. The syngenetic group includes magmatic segregations and sedimentary deposits. The epigenetic group includes contact-deposits, cavity fillings (including lodes) metasomatic deposits, and impregnations.

Having sketched in broad outline their scheme of classification, the authors deal with the causes which have determined the forms of the different deposits, describing in this connection the general principles of folding, faulting, over-thrusting, and the like. Then follow chapters on the minerals found in ore-deposits, on the various modes of formation of these minerals, on the relative distribution of the elements, with special reference to the metals, and on the origin of ore-deposits. The main causes to which the genesis of ore-deposits is attributed are crystallisation from molten magmas, pneumatolysis, contact-metamorphism, metasomatosis, precipitation from solution, and the mechanical concentration of pre-existing minerals. In dealing with the origin of ore-deposits by crystallisation or precipitation from solution, they practically discard the old, and at one time popular, theory of "lateral secretion," and accept the view that, if we leave out of account the effects of surface action on ore-deposits already formed, the solutions came from below and can in most cases be connected either directly or indirectly with igneous action.

Having dealt with general principles and given a historical sketch of the classifications adopted by different writers from the time of Werner to the present day, the authors proceed to consider the different types of deposit under four heads: (1) magmatic segregations, (2) contact deposits, (3) lodes, irregular cavity fillings, and metasomatic deposits, and (4) ore-beds. About half of the volume under review and the whole of the second volume, which has not yet appeared in English, is devoted to the description of typical occurrences. The first two of the above groups are dealt with in this book together with tin-lodes and quicksilver deposits which belong to the third group. As an illustration of the method of treatment adopted in this portion of the work we may very briefly summarise the account given of the nickel-pyrrhotite group of sulphide ores. These deposits form a widely-distributed and well-marked group. The most important characteristic common to them all is that they occur within, or at the margins of, masses of norite or gabbro. Thus of fifty occurrences in Norway by far the greater number occur in unaltered norite. The most important minerals are nickeliferous pyrrhotite, pyrite, and chalcopyrite. The pyrrhotite usually contains about 2·5 per cent. of nickel with some cobalt. Sometimes the proportion rises to 8 or even 12 per cent., but in such cases the presence of pentlandite, (FeNi)S, can be easily recognised and, owing to recent researches on metallographic lines, it may be regarded as certain that the abnormal percentages of nickel present in certain cases are due to admixed pentlandite; whether, in addition, a smaller nickel and cobalt content enters into the composition of pyrrhotite still remains an open question.

As regards the morphology of the deposits, the authors point out that transitions occur from normal gabbro or norite containing less than 1 per cent. of sulphides to rocks containing 10 or even 30 per cent. Such varieties are termed pyrrhotite-norite, and from these to masses of practically clean sulphides transitions may also be found. From these and many other facts, the authors conclude that the nickel-pyrrhotite deposits are the result of segregation from a basic magma. Having thus dealt with generalities, they proceed to describe individual occurrences, beginning with the most important of all, that of Sudbury, in the northern portion of Ontario. Their description of the Sudbury mining field is illustrated by a geological map of the area and by a plan and section of one of the important mines. A brief history of mining in the district is given, and the account concludes with a table showing the total production of the field and the average content of nickel and copper in the ore smelted at Sudbury. Then follow briefer descriptions of similar deposits in Norway, Sweden, and other countries.

A special feature of the work is the abundance and excellence of the illustrations. Each section is preceded by a bibliography, and the value of the book as a work of reference is thus greatly increased. Mr. Truscott has done his work so well that in reading the book one is apt to forget that it is a translation.

THE SIDEREAL PROBLEM.

Stellar Movements and the Structure of the Universe. (Macmillan's Science Monographs.) By Prof. A. S. Eddington. Pp. xii+266. (London: Macmillan and Co., Ltd., 1914.) Price 6*s*. net.

THE history of astronomy is in some ways exceptional among the sciences. It is the most laborious of all, and from this fact arises a certain apparent discontinuity. For years the work goes on, and outwardly there is no very conspicuous result beyond the piling up of records the true value of which must often be far from obvious at the time. Naturally, this part of the burden falls largely on the professional astronomer, though we do not forget men like Groombridge, inspired by a faith not always easy to analyse. Sometimes a line of work of evident value, like the attempt to measure the radial velocities of the stars, is prosecuted for years without any positive result before a new way of advance is opened by realising the correct principles of an appropriate instrumental design. Then the stream flows with astonishing rapidity, as the reader of Dr. Campbell's recent work on "Stellar Motions" may see. Even in the absence of a decisive factor of this kind there come times when different lines of inquiry are seen to converge, and with their confluence new points of view and fresh possibilities which affect the course of the science are suddenly opened out.

Such a time seems to have arrived about the beginning of the twentieth century. A large number of proper motions were known with increasing accuracy, the distances of a few stars had been fairly determined. Photometric studies were well advanced, and some progress had been made in the problem, apparently so simple but in reality so difficult, of counting the stars. Some of the cruder notions to be observed in Struve's "Etudes d'Astronomie Stellaire" had been generally discarded. But the prospect of a synthetic treatment of the sidereal problem seemed remote indeed. Prof. Eddington's review of the progress made in the last few years, to which he has himself made notable contributions, is exceedingly welcome. Here the results are stated in the clearest possible way, and the problems which have been solved or which lie before us in the future are defined in precise terms. It is a valuable work which will enable those who have not followed the progress made step by step to realise what has been accomplished, and from which those who have some familiarity with the matters discussed will derive much advantage by seeing the subject treated as a whole.

The scope of the book is in one respect rather severely limited. It is in no sense an historical account of the subject. The references to any investigations made in the course of the last century are merely incidental and exceedingly brief. For this the author himself expresses regret in the preface. To have traced the historic order by which the present situation has been brought about would have been beside the purpose of the work, and might have expanded it unduly. But a clear preliminary statement of what had already been accomplished by the year 1900 in elucidating the structure and tendencies of the stellar universe would have been very valuable. It would have made it possible to do a little more justice to the work of astronomers like Kapteyn, Seeliger and Kobold, and it would have furnished some standard of comparison by which to appreciate the present position.

Of the twelve chapters into which the book is divided the first two describe succinctly the data of observation which constitute the resources for attacking the problem and a general outline of the universe as the author conceives it. A singularly interesting chapter on the nearest stars follows, in which a most skilful use is made of the small sample of information open to discussion. The known examples of that simplest type of stellar motion in which the stars are recognised as possessing a common, uniform movement are next described. This conception originated with Mädler and Proctor, and, reinforced by a knowledge of radial velocities, bids fair to give detailed information, as opposed to merely statistical results, of the most illuminating kind. There is no reason to think that what has been done in this direction is more than a beginning.

After a chapter on the solar motion a full account of the two-stream theory, based mainly on Prof. Eddington's own researches, is given. The mathematical foundation of this theory and of Schwarzschild's ellipsoidal hypothesis is placed in a separate chapter, an excellent arrangement from the point of view of the general reader. The unmathematical reader must also pass over much of the statistical investigations in chapter x., though to the mathematician the application of the theory of integral equations to statistics will be particularly interesting. Except in these two sections the general reader should have no great difficulty in following the main line of the argument. Other chapters deal with those remarkable phenomena which are associated with the spectral classification of the stars, and which constitute the most significant discoveries in recent astronomy; the difficult problem of counting the stars in the sky according to magnitude, based largely on recent work at Greenwich, but paying perhaps an exaggerated respect to a well-known memoir of Kapteyn; and finally, the attempts which have been made to explain the stellar system in dynamical terms, attempts which seem rather premature in view of our still imperfect knowledge of the kinematical relations.

In conformity with the editorial scheme of the series to which it belongs, the book conveys throughout a strongly personal view, from which at some points the reader may be tempted to differ. But it is on the whole an eminently sane view, and this means much when in the nature of the case provisional judgments alone are possible. Ideas are in a state of flux, and gratitude is due to Prof. Eddington for fixing the phase of the moment in a permanent, accessible form. H. C. P.

THE ENAMELLING INDUSTRY.

The Raw Materials for the Enamel Industry and their Chemical Technology. By Dr. J. Grunwald. Translated by Dr. H. H. Hodgson. Pp. viii + 225. (London: C. Griffin and Co., Ltd., 1914.) Price 8*s*. 6*d*. net.

THE preparation of enamels for the purposes of ornament dates from a very remote period; we find them in use in ancient Egypt and Babylon, although in the earliest known specimens they were used as inlays in the metal objects they adorned, and not melted on them until somewhat later times It is not, however, until the beginning of the nineteenth century that the coating with enamels of iron hollow wares, saucepans, and the like for domestic use was practised, a process that many years afterwards was applied to the enamelling of iron in sheets and plates. The materials dealt with by the author are those employed in the manufacture of enamels for these purposes on a commercial scale.

The economic importance of the industry on the Continent is evident, if we consider that it gives employment in Germany to 25,000, and in Austria-Hungary to 19,000, persons; and a large part of the output finds a market in England.

The appearance of a translation of Dr. Grunwald's book is opportune at the present time, when methods are being discussed for the satisfactory organisation of our industries and the equipment of works, with the object of producing articles which hitherto have largely or entirely been made in other countries.

Its perusal brings forcibly to our notice the part which science has played, and is playing, in the management and control of the processes of the enamelling industry, and that complete success can only be attained by the co-operation of science and practical skill. Much scientific investigation, however, is still needed before certain hindrances to the success of many of the operations of the enameller can be successfully grappled with.

The object of the book is to supply those engaged in enamelling works with an account of the composition, properties, and limitations of use of the various materials employed and of their practical application on a large scale. An exact knowledge of these, it is scarcely necessary to point out, is absolutely essential in order to overcome the difficulties which often arise in works' procedure.

Much of the information contained in the book, it may be said, can be found in works on mineralogy and applied chemistry, but it is so scattered that, for purposes of reference, it is practically inaccessible to the busy worker.

The chief materials dealt with are the felspars, quartz, fluorspar, borax, cryolite, the alkalies, and the various agents for colouring and for giving opacity. The composition and properties of each are given at some length, and the nature of the impurities liable to be present and their effects on the character of the enamels are clearly set forth.

A point of practical importance is emphasised as regards the felspars that, as a rule, it is inadvisable to replace felspar silica by quartz or clay, even although the equivalent proportions are observed. In this connection it is well known that in enamels, as in many other substances, identity in chemical composition is often accompanied by considerable divergence in physical properties.

The author has evidently had considerable practical experience in enamelling, and the remarks appended to the description of each of the materials on their *rôle* and application in works' procedure, and the chapter on the composition of enamels, are specially valuable.

The accounts given, however, of the preparation of the materials are in a few cases of doubtful value, and in the case of the metallurgy of tin even inexact. It is, too, not obvious what useful purpose can be served by the introduction of the graphic formulæ of the felspars.

These are, however, minor defects. The book is a good one, and the appearance of a translation into English has rendered the industry in this country a valuable service. It should be in the hands of everyone connected with enamelling works.

W. G.

NEW BOOKS ON CHEMISTRY.

(1) *Van Nostrand's Chemical Annual,* 1913. Edited by Prof. J. C. Olsen. Pp. xiv+669. (London: Constable and Co., Ltd., 1914.) Price 12*s*. 6*d*. net.

(2) *A Text-book of Chemistry.* By W. A. Noyes. Pp. xv+602. (London: G. Bell and Sons, Ltd., n.d.) Price 8*s*. 6*d*. net.

(3) *The Electrical Conductivity and Ionisation Constants of Organic Compounds.* By Dr. H. Scudder. Pp. 568. (London: Constable and Co., Ltd., 1914.) Price 12*s*. 6*d*. net.

(1) "VAN NOSTRAND'S Chemical Annual for 1913" is arranged on much the same lines as the well-known German "Chemiker Kalendar" of Biedermann. It contains a great number of tables of constants and a vast amount of other information useful to chemists. It is, in short, the kind of reference book which no practical chemist can afford to be without; for the amount of time it must save will soon repay him for its rather high price.

Seeing that the bulk of each annual issue is a mere copy of a former one, it seems as if something could be devised whereby the small amount of new matter and corrections might be published separately without the expense of repurchasing the whole volume. The present issue is embellished with an excellent portrait and a short obituary notice of Prof. Henri Moissan.

(2) A text-book written for beginners is always difficult to appraise at its true value unless one has some notion of the character and extent of the oral and practical teaching which necessarily accompany it. As it stands there is little to find fault with in this volume, either in regard to the arrangement of subjects, the descriptive portion, or the facts, yet unless there is a great deal of amplification we have grave doubts if it could be recommended unreservedly as a satisfactory first text-book. The matter is condensed into short paragraphs dealing with a great variety of topics. We find, for example, in the first hundred pages or thereabouts, in addition to much experimental information, accounts of the ionic theory, equilibrium, reversible reactions, catalysis, valence, the phase rule, the atomic theory, the van 't Hoff-Le Chatelier law, molecular volumes, etc. Even the "quantum theory" is introduced later in a paragraph of fifteen lines, and we have no hesitation in saying that, in so far as it attempts to convey any information, it is so much wasted space.

The book is, in short, a *multum in parvo,* no doubt excellent as a summary of many and divers facts and theories.

We would ask again, as we have frequently done in reviewing other elementary text-books, whether any object is served by introducing at the beginning definitions and generalisations of the nature of which the student has as yet only vague ideas? Is anything substantial to be gained by stating (p. 5) that matter is anything which has mass, or that matter is anything which requires energy to set it in motion, when, on the next page, energy is defined as anything which may set matter in motion?

A great difference is often observed in the attitude of students towards physics and chemistry, and the reason probably is that in the one he is taught to reason logically, because he is made to think logically; in the other he is confronted with phenomena about the nature of which he is rarely encouraged to express his opinion, because he is provided, often unconsciously, with the explanation. The paragraph on elements and compounds (p. 9) affords an illustration. "If the red oxide of mercury is heated in a small tube, metallic mercury will distil, whilst a glowing splinter held at the mouth of the tube will burst into flame. The heat causes the decomposition of the oxide of mercury into mercury and a gas which is called oxygen."

It is a gratuitous assertion that the phenomenon is one of decomposition; why not say with the old phlogistonists that the red powder has combined with something in the air to form the metal and left the oxygen? Until the loss of weight is recognised this explanation is equally logical; but then, of course, if we begin by calling the substance oxide of mercury we merely end by proving what we have tacitly assumed at the outset.

(3) Dr. Scudder's book is a complete bibliography of the ionisation constants of all the organic compounds which have appeared from 1889 to 1910 inclusive, with corrections down to 1913. That the work involved in compiling these tables must have been enormous may be estimated from the author's statement that 78 journals and

5000 separate memoirs have been examined page by page. The substances are arranged in alphabetical order, and are also indexed according to formulæ. The references are indicated by numbers which correspond to the index of authors given at the end of the volume.

The book is well printed on good paper, and is solidly bound in cloth. It is the only complete work on the subject, and will be a valuable addition to English standard books of reference.

J. B. C.

OUR BOOKSHELF.

Boilers, Economisers, and Superheaters: Their Heating Power and Efficiency. By Prof. R. H. Smith. Pp. viii + 128. (London: Crosby Lockwood and Son, 1915.) Price 7*s*. 6*d*. net.

THE author's purpose in this book is to provide material whereby the designer of steam boilers may take account of the transmission of heat by radiation from the incandescent fuel and the incandescent parts of the flame in as full and scientific a manner as the data at present available makes possible. It is assumed that combustion is completed within, or close to the surface, of the mass of coal, and that the heat so produced is divided between heating the solid coal and heating the generated gases. This assumption enables the furnace gas temperature to be calculated for various ratios of air actually admitted to the furnace to the air required by chemical theory, and for various heating values of the fuel. The result indicates that the temperature depends almost solely upon the air ratio, and to a minute degree only upon the heating value of the coal. The heat given up by the gases passing along the flues is then dealt with and similar calculations are given for economisers; applications to superheaters form the subject of a separate chapter. The laws of heat transmission in boilers are too complex for ready use in engineering drawing offices, and the author has reduced these laws to the form of diagrams. It is unfortunate that these diagrams, while showing the way in which the quantities involved vary, are reproduced to a scale too small to be read accurately; the reader interested in boiler design is invited to purchase copies of the original large-scale diagrams. There is a great deal of interesting and useful matter in the book, but it is not presented in a very readable form, and the practical designer is likely to consult the diagrams much more frequently than he will refer to the text.

Through the Grand Canyon from Wyoming to Mexico. By E. L. Kolb. Pp. xix + 344. (New York: The Macmillan Co; London: Macmillan and Co., Ltd., 1914.) Price 8*s*. 6*d*. net.

THIS is a graphic but unassuming account of one of the very few successful descents through the country of the Grand Canyon by boat from end to end. For European readers it should have contained a map, to ensure the appreciation of the vast distances involved and the remoteness from civilisation of the plateau-heights on either hand. Anyone who has travelled along gorges, such as the Bosnian canyon of the Vrbas, will realise the effect of a sudden contact with the outer world, where some trail descends by a gentler part of the valley-side, finds a passage across the river, and climbs again to the upper air. Such episodes, leading to the visiting of ranches where pioneers and outlaws still lead unhampered lives, broke the long series of hazards which the fearless author and his brother set before themselves. No two of the cataracts are alike, and the tale is so well told that the reader feels himself limited by rock-walls 4000 ft. in height; he sees the huge fallen blocks that seem to bar the passage, the spray rising from some swift descent ahead, the fierceness of which cannot yet be adequately gauged; he feels the whirl of the water round him in the rapids, where the boat twists like a porpoise in green waves; and at the end, among the sand-bars and marshes close to Needles, after a hundred-and-one days of travel, he takes leave of his guides with a genuine and affectionate regret.

The brothers Kolb are professional photographers, as the fine illustrations in this book so amply testify. The famous journey of J. W. Powell in 1869 is, of course, fully acknowledged, and references are given to Stanton, Galloway, Stone, and to the nameless trappers or prospectors who are known to us only by shattered boats or bleaching skeletons in the gorge. The geological study of the district has aptly influenced Mr. Kolb's descriptions, and seldom has a great adventure, carried out with skilled endurance, been told so simply and with so fine an absence of self-regard. GRENVILLE A. J. COLE.

Pumping by Compressed Air. By E. M. Ivens. Pp. vi + 244. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 12*s*. 6*d*. net.

IN compiling this book the author has had the advantage of being able to draw on considerable practical experience derived from installing and testing air lifts operating under a wide range of conditions. Very good and clear descriptions are given of various types of displacement pumps, return air systems, air lifts, and pumping systems generally. Of particular interest are the sections dealing with the air lift. In this system a long vertical pipe is led down the well, and has an open mouth near the bottom and under the water-level, so that normally the water stands at a considerable height inside the pipe. Compressed air is led down the well by a separate pipe, and is discharged through suitably shaped orifices into the first-mentioned pipe at a point well below normal water-level. The ascending bubbles of air cause an upward flow of water, which is finally discharged into a tank at or above ground-level. The theories of Harris and of Lorenz regarding the action in air lifts will be found in the book, together with much matter of practical interest. The practical treatment is good, and forms a useful addition to a subject the literature of which is not extensive.

In dealing with the more theoretical matters concerning the laws of expansion and compression of gases the author is not so fortunate, and there are a number of loose and careless statements. Thus on p. 160 we find Boyle's law stated as follows: At constant temperature the volume of gas is proportional to the absolute pressure. The author is not unaware of the fact that the volume is inversely proportional to the absolute pressure, but this and other similar careless statements of facts mar an otherwise good and useful volume, and call for a thorough revision for the second edition.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Electrical Notation.

SIR JOSEPH LARMOR'S letter in NATURE of January 21 (p. 561) reminds me that I have long wished to protest against the misuse of alphabetical symbols to designate the names of units. The word *ohm*, for instance, ought not to be abbreviated to ω; and the apparently authoritative suggestion now made that other names shall be written in the same sort of unreadable and worrying shorthand is essentially, though not superficially, illiterate as well as utterly unmathematical.

The *naming* of units has been conspicuously useful; the consumption of much-needed and already overworked symbols as substitutes for names is a wasteful practice which should be resisted among physicists, and be only tolerated in microscopy for purely biological use.

OLIVER LODGE.

University of Birmingham, January 23.

Mendelism in the Seventeenth Century.

THE Mendelian revival of breeding has brought to light many interesting facts concerning the inheritance of coat-colour in rabbits. From the work of Hurst, Castle, Punnett, and others, it is now known that when the wild "grey" or "agouti" rabbit is mated with white, black, or "blue" specimens, the offspring produced all display the colour of their wild parent. Although this is doubtless well known at the present day, it is, I believe, not generally known that these facts had been ascertained by rabbit-fanciers in Holland in the seventeenth century, and were put on record by the illustrious Leeuwenhoek in 1683.

In a letter from Leeuwenhoek to the Royal Society, addressed to Sir Christopher Wren, and dated July 26, 1683, the following remarkable passage occurs:—

"Multi nostratium civium alunt cuniculos, cum ad voluptatem, tum ob lucrum: suntque hi cuniculi plerumque magni atque albi, auribus praelongis donati, quod pulchritudinis loco ducunt. Ut vero hi cuniculi in lucem edant pullos grisei sive cinerei coloris, qualis est sylvestrium, utque pro his possint verno tempore vendi, foemellae albae marem griseum ac sylvestrem ex tumulis arenarum petitum, ubi omnes grisei coloris sunt, sociant: atque tales masculos intense griseos committunt non tantum cum albis, sed & versicoloribus, nigris, caeruleis foemellis: Ex quibus tamen quicquid procreatur, colorem patris refert; ut nunquam etiam observatus sit ullus ex tali jugatione productus cuniculus, qui fuerit capillo albo, aut alio quam griseo. Praeterea tales nunquam attingunt magnitudinem matris, neque aures acquirunt praelongas, neque pro matris natura plane cicurantur ac mansuefiunt, sed retinent semper aliquid ferocioris ferinaeque naturae ac indolis."

The letter will be found in the so-called "Opera Omnia" of Leeuwenhoek (Lugd. Batav., 4 vols., 1722). Owing to the confusing arrangement and pagination in this work—which consists of a number of separate sections, published at different dates, each with its own pagination—it is not easy to give an exact reference to a particular passage. In the copy of the "Opera Omnia" which I have consulted, the letter occurs on p. 49 (first pagination) of vol i. ("Anatomia et Contemplationes"), under the title, "De generatione Ranarum," etc. The passage in question begins at the foot of the following p. 53.

I may add that the letter is not to be found in Samuel Hoole's English edition of Leeuwenhoek's "Select Works" (London, 2 vols., 1798, 1807). This translator expurgated all Leeuwenhoek's letters dealing with spermatozoa. He calls them "Disquisitions of a peculiar kind, which to many Readers might be offensive."

Feeling some doubt as to the colour or marking which "*versicolor*" is intended to denote, I compared the Latin letter with an English version which was published under the title, "*An Abstract of a Letter from* Mr. Anthony Leeuwenhoeck *of* Delft *about Generation by an* Animalcule *of the Male Seed*, etc.," in the *Philosophical Transactions* of the Royal Society, vol. xiii. (xii.), p. 347, 1683. Both Latin and English versions are translations from the Dutch: for Leeuwenhoek could write no language but his own. In the English version, which is somewhat differently worded from the Latin, the words "*versicoloribus, nigris, caeruleis*" are rendered "Blew, Black, and Pyed." "*Versicolor*" evidently denotes some kind of piebald marking; though it probably does not mean—as one might perhaps conclude—the modern "Dutch" pattern. This, Prof. Punnett tells me, is of comparatively recent introduction, and has superseded an earlier or "original Dutch" marking which "has less white and has practically dropped out of the fancy."

It is clear from Leeuwenhoek's words that the Dutch rabbit-fanciers had, as early as 1683, discovered that the offspring produced by mating wild "grey" buck rabbits with tame long-eared white, black, blue, or piebald does, are always exclusively grey in colour; and that they are sufficiently like the wild rabbit in other respects also for them to be marketable as such.

Leeuwenhoek's statement that the hybrids produced by crossing piebald with wild rabbits are invariably "grey" in colour—without any white—seems open to question. Recent experiments have not yet solved the problems of the inheritance of pied patterns in rabbits. Prof. Punnett, who has been studying the matter for some years, tells me that when wild rabbits are crossed with modern Dutch, "the F_1 animals may be, though rarely, completely self-coloured. Generally they have a little white. The amount of this varies, but never approaches the amount found in the Dutch."

The statement that the progeny of long-eared tame doe-rabbits and wild males never possess such long ears as their mothers, appears to have been confirmed by Castle. "He crossed the long-eared lop rabbit with ordinary short-eared individuals. F_1 had ears o intermediate length" (Bateson, "Mendel's Principles of Heredity," 1909, p. 251). I do not know of any confirmation or contradiction of Leeuwenhoek's fina assertion that the offspring of wild males and tame females tend to manifest the wild temper of their fathers.

It seems remarkable that nobody—so far as I am aware—has hitherto directed attention to the passage which I have quoted above. It occurs incidentally in a letter which described such novelties as the spermatozoa and red blood-corpuscles of the frog, and the ciliate Protozoa parasitic in the frog's intestine. But it is perhaps even more remarkable that neither Leeuwenhoek at the time, nor anybody else for some two hundred years subsequently, perceived the importance of such observations as the rabbit-fanciers of Holland had made. Leeuwenhoek was, of course, an "animalculist": and he cites the case of the rabbits to confute "*non nemo Doctorum*"—evidently an "ovist"—and to "bring a sufficient proof of the fruits coming from the *Male seed*, and the *females* only contributing to the nourishment and growth of it."

Leeuwenhoek's remarks evidently do not constitute the earliest known reference to rabbit breeding. For Darwin ("Animals and Plants," chapter iv.) gives earlier references to Gervaise Markham (1631), and Aldrovandi (1637), which show that several kinds of rabbit were already kept and bred at the beginning of the seventeenth century. Nevertheless, the passage which I have quoted above is, perhaps, the earliest exact account—based upon experiment—of the inheritance of any character in any animal or plant; and as such I think it is worthy of record.

I am indebted to my friend, Prof. R. C. Punnett, F.R.S., for information on certain matters mentioned in this letter; and I would refer the reader interested in the subject to his important paper, "Inheritance of Coat-Colour in Rabbits," published in the *Journal of Genetics*, vol. ii., No. 3, 1913, for further facts.

Clifford Dobell.

Imperial College of Science, South Kensington,
London, S.W., January 15.

Books for Belgian Students.

We are gradually building up a little Belgian University here for students who, for one reason or another, cannot go to the front, and for professors who are past the age of serving. Altogether we have between one hundred and two hundred students, and some fifteen to twenty professors.

Last term we were able to establish effective teaching in four faculties, and this term we have increased the number to six. In the faculty of medicine we are in need of copies of some standard text-book on human anatomy—preferably Gray's.

This University has already found several thousand pounds to support our guests, and will have to find several thousands more to keep things going until next June. Consequently we have to husband our resources very carefully, and cannot afford to purchase such expensive text-books as Gray's "Human Anatomy."

It may be that your readers have copies of this work lying unused on their shelves. If this is so, I should be grateful if they would send them to me for the use of these students. At present ten or a dozen copies would suffice.

A. E. Shipley.

Christ's College Lodge, Cambridge, January 25.

An Unexplained Laboratory Explosion.

I shall be glad if any of your readers can give me an explanation of the following occurrence.

Owing to the fact that we are somewhat out of the way here, and, in consequence, fresh bleaching powder is difficult to obtain, I have found it necessary, when demonstrating the formation of chloroform, to find some method other than the usual treatment of alcohol with bleaching powder.

With this object, a few days ago I prepared a mixture of 60 grams of slaked lime with 400 c.c. of cold water and 40 c.c. of alcohol. The mixture was placed in a 2000 c.c. flask, through the cork of which a long tube conducted chlorine to the bottom of the liquid. Through the cork also went another short tube connected to a condenser.

Chlorine had been passing into the liquid fairly quickly for about twenty minutes, and the contents of the flask had warmed up to perhaps 50° C., when a slight smell of chlorine became evident at the end of the condenser, together with a small amount of white fumes; but inside the big flask, except for the slight rise of temperature, there was no evidence of chemical action. Suddenly, with no warning whatever, the whole apparatus blew up; I might almost say detonated, as there was not a piece bigger than a sixpence left, either of the flask, the condenser, or the small flask put to catch the distillate when it should arrive.

Owing perhaps to the violence of the explosion, I got off with a few scratches on my face. My clothes were cut by pieces of glass, however, and the fragments were scattered for at least six yards all round. There was no odour, either of chloroform or anything else, apparent; only that of the chlorine from the generating flask, which, curiously enough, had escaped injury. The whole delivery tube was intact, and also the exit tube from the big flask, the neck of which, with the cork, was left sticking in the clamp, so that I was able to be sure that the trouble was not due to a blocking up of the exit.

W. F. A. Ermen.

O. Granbery, Juiz de Fóra, Minas,
December 11, 1914.

Demonstration of Strain-hardening of Steel.

The accompanying photograph (Fig. 1) represents the side of a steel bar. The bar was first marked by a punch in the way shown, and the punch marks were afterwards completely filed out. The side was then polished and the bar pulled in a testing machine beyond the elastic limit of the material. The polished surface was gradually destroyed everywhere except just under the punch marks, where the overstrained material retained its polish and the marks again became evident. In the strained bar the marks remain distinctly raised above the rest of the surface. A similar experiment was made with a shorter bar that was afterwards subjected to compression along its length. Again the punch marks became clearly visible, but this time they remained as polished depressions instead of raised surfaces.

Fig. 1.

R. W. Chapman.

The University of Adelaide, South Australia,
November 30, 1914.

BY-PATHS IN NATURAL HISTORY.

(1) THE aim of Mr. Dugmore's copiously-illustrated book is not only to portray the beaver as a living piece of Nature's marvellous work, but also to explain how the harmless little creature can justify its existence before man, and how it has established its claims to consideration at the hands of civilised humanity and to that legal protection from the State which has been so grudgingly accorded to it. It may at once be said that in every particular, except that for which the bookbinder is responsible, the volume is a success.

The author begins by describing in the fullest detail the working habits of the beaver; its doings as a woodcutter, an architect, and a roadmaker, and most of all as a skilled constructor of dams, canals, and other works for the control of waterways. Here the author has a good deal to say about the unknowable psychological influences that lie behind all these wonderful operations—the selection and preparation of trees for felling, the clearing of the road beforehand, and the nice carpenter's calculations afterwards, the hydrographic survey work, the neat appreciation of the essentials of hydrostatics, the management o floating bodies, the utilisation of currents an backflows, etc. Is it all instinct, or is some of i fore-knowledge, and conscious anticipation o results? "Where is the way where ligh dwelleth?" It is unprofitable to discuss insolubl problems, but while it is reasonable to believe tha the animal, however subject to innate impulses must also make inferences in the same way a man does, it is extravagant to suppose that i has a perfect understanding of its doings—that i formulates its experiences and reflects upon thei practical application.

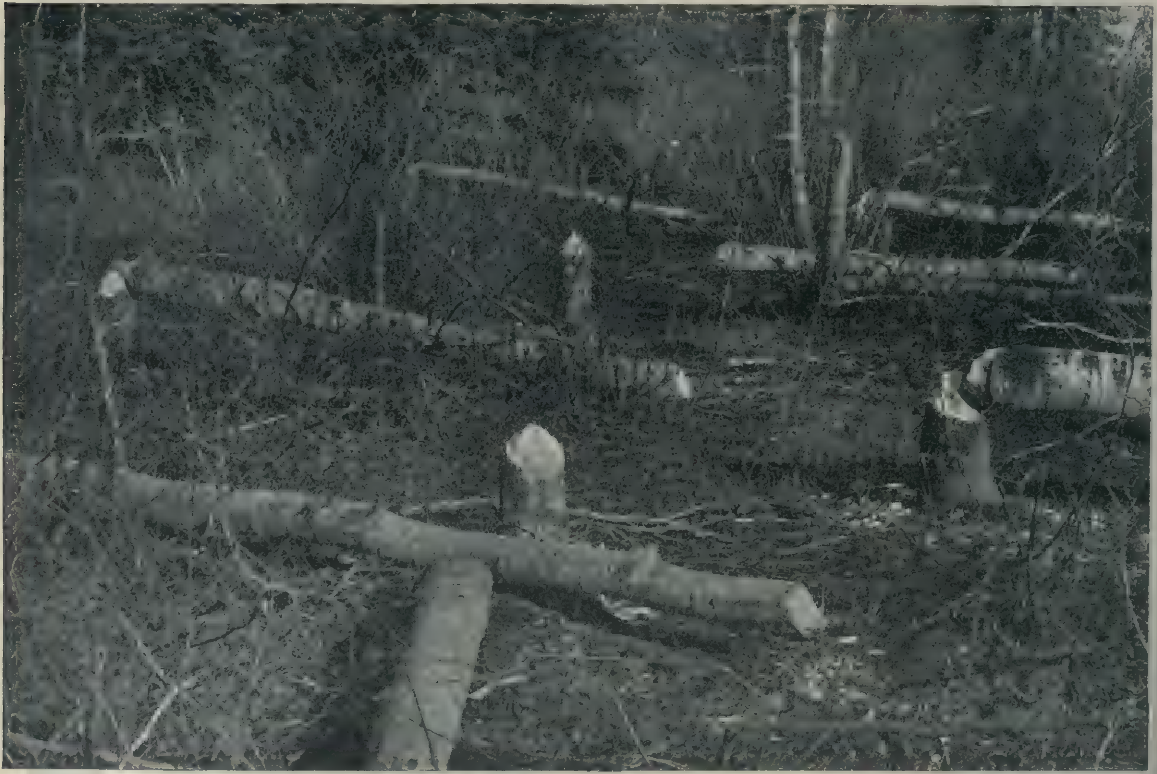

Photo.] [A. R. Dugmore.

Part of a poplar grove which was completely cut down by a small colony of beaver. It will be seen that the trunks are entirely stripped of their branches, which were carried away to the storage pile. From "The Romance of the Beaver." (Heinemann.)

Another chapter deals with the life-history of th animal—its birth and growth, its family and socia relations, and the ordinary vicissitudes of its existence.

A third section treats of the beaver as an agen in modifying the face of the earth, in particula by converting insignificant streams into chains o ponds and lakes. Such reservoirs, so long as th beavers are there to attend to the dams, bring i their train many benefits and conveniences, dire and indirect; and after the animals have disappeared may become rich alluvial flats, the best tillage for man. On these and other good groun the author ardently advocates the protection the beaver by statute, notwithstanding the fa that it does a certain amount of damage to timb —mainly, however, of inferior kinds. His gener remarks upon the protection of wild animals a

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[1] (1) "The Romance of the Beaver. Being the History of the Beaver in the Western Hemisphere." By A. R. Dugmore. Pp. xiv+225. (London: Wm. Heinemann, n.d.) Price 6s. net.

(2) "Bird Biographies and Other Bird Sketches." By O. G. Pike. Pp. xi+180. (London: Jarrold and Sons, n.d.) Price 6s. net.

(3) "Concerning Animals and Other Matters." By E. H. Aitken ("Eha"). Pp. x+196. (London: John Murray, 1914.) Price 6s. net.

particularly opportune at a time when, in the name of the beneficent goddess Hygeia, people who ignore the marvellous interdependence of all the specific parts of the organic world, are proposing to exterminate blindly large elements of the mammalian fauna of great tracts of country in Africa.

(2) To entitle these promiscuous sketches "bird biographies" seems at first sight rather to take bird-bolts for cannon-bullets, until one considers the illustrations, and attempts to realise the time and labour, and the prodigious patience, to say nothing of the numerous kinds of technical aptitude, that they represent. These illustrations are the feature of the book, and they do equal credit to the skill and the taste of the author and his assistant; all the familiar British birds are here, from the ousel cock so black of hue to the wren with little quill, as well as many that are not so familiar, as the buzzard, the raven, the grey goose, the grebe, and the dipper. The admirable series that portrays the seven ages (more or less) of the buzzard are quite perfect.

In their literary and other aspects the sketches are simple, careful, and unlaboured, and are replete in observation and information at first hand.

(3) Of this little volume about half is concerned with animals, and the rest with "other matters" relating to India—stories woven round familiar Indian types, sketches of social and ethnological and philological interest, brief flights to the borderland of politics and economics, etc.

A charming little essay on the coconut-tree may be selected as illustrating to perfection not only the author's happy knack of finding tongues in trees and good in everything, but also the quickness and diversity of his fancy and his easy grace of expression. Here, starting from a familiar commodity of the sweet-shop, he suggests an Oriental sea-shore with its background of palms swaying in the salt-laden breeze, and, like the old traveller Ludovico di Varthema, tells in a few significant words how *Cocos nucifera* is still the tree of life to the village communities that dwell beneath its kindly shade, bringing from the wonderful earth unfailing gifts of food, oil, wine, fuel, timber, and fibre for spinning, besides building-material and domestic utensils almost ready-made. In an age of mechanical crafts, so confident of its "progress" as to forget that a polity not surely rooted in agriculture is at its best an interesting pathological specimen and at its worst an unholy chaos, it is a joy indeed to find a popular writer who can reveal so clearly the paraphernalia of a modest civilisation issuing so readily from one benign tree. After the same fashion the author hangs upon the betel-nut-palm and other common natural objects piquant discourses, full of sage hints and quaint diversions, on social and ceremonial attitudes characteristic of the East. On the other hand the essay on Indian poverty goes, but with the same humane touch, into the etiology of certain prevalent diseases of the body politic, and criticises with severity but without rancour the arrogance of the complacent zealots who aspire to cure them.

Kingfisher outside her nesting hole. From "Bird Biographies and other Bird Sketches."

The essays on animals are full of humorous suggestions. The best are those which recount the author's own observations and reflections upon living creatures, although those in which by an ingenious blend of adroit jest and teleological version of fact the author—ably supported by the artist—brings out chiefly the comical aspects of animal life may, perhaps, be more appreciated by the general reader.

A chapter on cures for snake-bite is intended to illustrate the play of vernacular superstition rather than to explain the rational basis of European methods of treatment, but since the history of acquired immunity to snake-poison and of the attendant discovery of antivenine is outlined, it is a pity, perhaps, that the names of Sewall and Calmette were not mentioned among the great original *dramatis personae*.

THE NEW ISSUE OF THE BRITISH PHARMACOPŒIA.

THE publication of a new issue of the British Pharmacopœia is an event of considerable importance to the medical as well as to the pharmaceutical world. It reflects, so far as is compatible with official recognition, the changes that have taken place in the opinion of physicians as to what drugs and preparations are of sufficient importance to be included in it, and the opinion of pharmacists as to how such drugs are to be defined and such preparations of them to be made. Though the Medical Act of 1858 requires that the General Medical Council shall cause the British Pharmacopœia to be published, it is well known that the labour of revision, in so far as it relates to the monographs and appendices in the work, has been carried out, practically in its entirety, by the Committee of Reference in Pharmacy to which somewhat scanty acknowledgment is made in the preface. That to pharmacists alone this most responsible part of the revision can safely be entrusted has long been officially recognised in most countries in which a pharmacopœia is published, and the opinion has been freely expressed that the time has now arrived when British pharmacists should occupy a more satisfactory position in the revision of future issues of the British Pharmacopœia.

Such of the articles and preparations of the Indian and Colonial Addendum of 1900 as were deserving of retention have now been embodied in the text, but it is observable that a large proportion has been dropped; of those retained the following alone are used to some extent in this country: couch grass, arnica flowers, black catechu, cotton-root bark, grindelia, ghatti gum, rhizome and resin of Indian podophyllum, and black haw bark.

The additions to the Pharmacopœia are not numerous, there being only forty-three. The most important of these are acetone, acetylsalicylic acid, picric acid, adrenalin, barbitone (diethylbarbituric acid, also known as veronal), benzamine lactate (beta-eucaine lactate), calcium lactate, cantharidin, chloral formamide, cresol, diamorphine hydrochloride (diacetylmorphine hydrochloride), ethyl chloride, guaiacol, guaiacol carbonate, hexamine (hexamethylenetetramine), ipomoea root (the so-called Mexican scammony root from which scammony resin may now be obtained), solution of adrenalin hydrochloride, solution of formaldehyde, solution of formaldehyde with soap, methyl salicylate, methylsulphonal, phenolphthalein, resorcin, acid sodium phosphate, strontium bromide, and theobromine and sodium salicylate (diuretin). The number of new synthetic drugs is therefore remarkably small, and affords an indication of the opinion of the medical profession of the permanent value of the host of such remedies that have been introduced during recent years.

The omissions, 166, are far more numerous, the following being the most important of the drugs discarded: arnica rhizome, bismuth oxide, gamboge, cantharis (now replaced by cantharidin), coca leaves (now replaced by cocaine and its hydrochloride), saffron, galbanum, jaborandi leaves (now replaced by pilocarpine nitrate), hops, mezereon bark, calabar beans (now replaced by physostigmine sulphate), elder flowers, sarsaparilla, scammony and mustard. As a general rule the preparations of discarded drugs have also been omitted; of other preparations reference may be made to the class of concentrated liquors, all of which have been deleted.

Alterations in strength are not numerous, nor are they, with a few exceptions, important; many of them have been necessitated by the endeavour to comply with the recommendations of the Brussels International Conference, an endeavour which has for practical purposes been effectively accomplished. The greatest change has been in tincture of strophanthus, which is now four times as strong as it used to be, and the most far-reaching that of tincture of opium, which has been increased in strength by one-third.

Perhaps the most conspicuous change in the Pharmacopœia is the omission (except from the doses) of all imperial weights and measures. The dual system of the issue of 1898, which was a constant source of trouble, has therefore been abolished, and the formulæ are in general now arranged to produce 100 or 1000 parts by weight or volume. The percentage composition is thus evident at a glance, and considering the present extensive use of metric weights and measures no inconvenience should arise from the change. The use of the term "millilitre" instead of "cubic centimetre," appears strange at first, but it must be admitted that the millilitre, though not in general use, is the more strictly correct designation. "Mil," "decimil," and "centimil," convenient contractions that have been recognised by the Board of Trade, are used in stating the doses. A "drop" is no longer a vague and variable quantity; in accordance with the International Agreement the external diameter of the dropping tube is to be exactly 3 millimetres, 20 such drops of water at 15° being equivalent to 1 millilitre.

Volumetric solutions are now designated as N/1, N/10, etc., in agreement with common usage. The directions for preparing these solutions have been omitted from the appendices, the statement only of the strength corresponding to the designation being made. No fewer than twenty-five volumetric solutions are employed in the present Pharmacopœia as compared with eight in the last. Temperatures are expressed in degrees centigrade, and the atomic weights adopted are those agreed upon for 1914 by the International Committee.

When the monographs are scrutinised it is seen that scarcely any have escaped alteration of some kind, and that most have been notably improved. The verbosity of the last Pharmacopœia has been replaced by a terseness that is sometimes almost harsh. Whenever possible the monograph contains in the first few lines a definite statement of the minimum permissible percentage of pure substance, alkaloid, etc., and a means is given by which this may be ascertained. Particular attention is devoted to the proportion of those dangerous impurities, lead and arsenic, that may not be exceeded. No fewer that fifty-six such lead and ninety-one arsenic limits have thus been introduced; the methods for determining them are given in the appendices, and are those originally introduced by Mr. C. A. Hill and now in general use in pharmaceutical laboratories.

The monographs for the volatile oils, fixed oils, fats, etc., have also undergone thorough revision. In most of them the limits of specific gravity, optical rotation, and refractive index are stated; determinations of acid value, saponification value, iodine value, ester content, and alcohol content are frequently given, in addition to which the assay for a particular constituent, such as cineol, cinnamic aldehyde, etc., is also introduced where desirable.

The monographs of crude drugs and galenical preparations have undergone a similar thorough revision. In the former the most conspicuous change has been the extension of the microscopical characters; these are fully described whenever the information is important for the identification of the drug, and in many cases the microscopical characters of the powder are also given. The principle of standardisation has been extended, and the assay processes of the last Pharmacopœia have been revised in the light of recent investigations.

Allusion has been already made to some of the additions and alterations in the appendices. The articles and reagents used in chemical testing are, with few exceptions, defined as those "of the British Pharmacopœia" or "of commerce, pure." Appendix xvii. consists of a list of abbreviated Latin names introduced as the result of a communication from the chairman of the United States Pharmacopœial Convention; this is a distinctly novel feature. No suggestion is made that either pharmacists or physicians should employ these abbreviations, and it remains to be seen whether the introduction will have any practical value.

Looking at the Pharmacopœia as a whole, it is evident that the general principle on which the revision has been carried out has been that of substituting practical for theoretical or academical standards. Many of the methods adopted have already been subjected to prolonged trial in pharmaceutical laboratories, and the limits fixed are those which have been found to be practically attainable. The reports that have from time to time been issued show that most of the suggestions and data for these improvements have emanated from the Committee of Reference in Pharmacy, and to this body full credit should be given for the revision it has accomplished successfully.

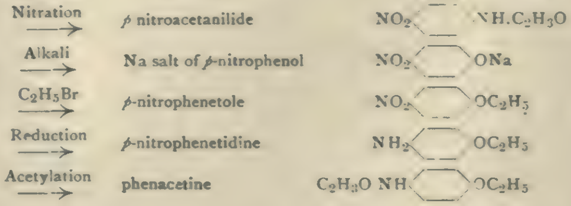
SYNTHETIC DRUGS IN GREAT BRITAIN.

AT the commencement of the war, the sudden cessation of all supplies of synthetic drugs from German sources rendered it probable that the stocks in hand in this country would not be sufficient to meet the demand until such time as the English manufacturers could adapt themselves to the altered conditions. Early in September, therefore, the Admiralty asked the Imperial College of Science and Technology to prepare for them 30 lb. of phenacetine, 50 lb. of hexamethylenetetramine, and 1½ lb. of β-eucaine. For the past five months the staff and research students of the Organic Department of the college have been engaged in carrying out this request, with the result that the required quantities have now been forwarded to the Naval Hospitals at Haslar, Chatham, and Plymouth.

With the exception of salvarsan, which is being made by Messrs. Borroughs and Wellcome, and aspirin, which is now being made by Messrs. Boots, Ltd., no synthetic drugs have been manufactured previously in this country. As regards drugs from natural sources, however, it is probable that English firms have always produced very much more than the German firms.

PHENACETINE is a product of the Baeyer firm at Elberfeld and has never been made before in this country. It is probable that all the phenacetine in commerce emanates from this firm, although it is understood that the immediate needs of this country are now being met by the importation of considerable quantities of this drug from the United States of America.

After numerous experiments, the method found most suitable to the conditions prevailing in a scientific laboratory was that shown by the series:—

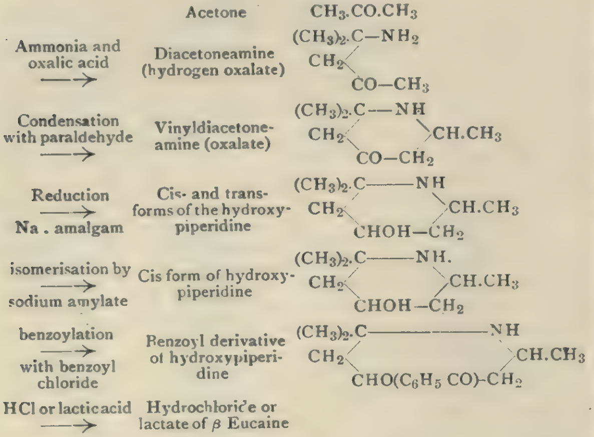


The various operations were so arranged that ultimately 1½ lb. of pure phenacetine were prepared daily, the by-products being recovered and used again.

HEXAMETHYLENETETRAMINE.—The preparation

of this drug is a comparatively simple matter, involving the treatment of a solution of formaldehyde with ammonia. It is understood that the compound is now being prepared in considerable quantities in this country.

β-EUCAINE, which is an important local anæsthetic, has not been prepared in England hitherto, and there is apparently very great difficulty in obtaining any of it for medicinal use. The preparation of the drug is a long and tedious process, and many initial difficulties had to be overcome before the correct conditions were found. Ultimately the following general scheme was worked out, and found to give satisfactory results:—


Acetone
CH3.CO.CH3
Ammonia and oxalic acid
Diacetoneamine (hydrogen oxalate)
(CH3)2.C—NH2
CH2
CO—CH3
Condensation with paraldehyde
Vinyldiacetone-amine (oxalate)
(CH3)2.C—NH
CH2
CH.CH3
CO—CH2
Reduction Na. amalgam
Cis- and trans-forms of the hydroxy-piperidine
(CH3)2.C—NH
CH2
CH.CH3
CHOH—CH2
isomerisation by sodium amylate
Cis form of hydroxy-piperidine
(CH3)2.C—NH.
CH2
CH.CH3
CHOH—CH2
benzoylation with benzoyl chloride
Benzoyl derivative of hydroxypiperidine
(CH3)2.C—NH
CH2
CH.CH3
CHO(C6H5 CO)-CH2
HCl or lactic acid
Hydrochloride or lactate of β Eucaine

It should be added that the cost of the materials used in these preparations was defrayed by the Imperial College, and that the services of the workers were given gratis.

J. F. THORPE.

NOTES.

AT the anniversary meeting of the Royal Astronomical Society, to be held on February 12, the question of the admission of women will again be brought forward; and it will be proposed that the council take all necessary steps to render their election possible. Whatever arguments may, from selfish motives, be used against the admission of women to membership of professional corporations, no logical reason can be found for excluding women from societies which exist purely for the advancement of scientific knowledge. In astronomy women have shown aptitude for observation and exceptional powers of description. So long ago as 1828 the Royal Astronomical Society awarded its gold medal to Caroline Herschel for the help she had given her brother (her work as an original discoverer was overlooked at that time); and the society has already two lady honorary members, namely, Lady Huggins, elected in 1903, and Miss A. J. Cannon, of Harvard College Observatory, elected last year. Other well-known names of women who have done notable work for astronomy are Mrs. Somerville, Mrs. Roberts (Mdme. Klumpke), Miss Agnes M. Clerke, Mrs. Maunder, and Mdme. E. Chandon (Paris Observatory). Women have for some time attended meetings of the Royal Astronomical Society by invitation of the council; and the society should now take the further step of converting the favour to a right. Among the scientific societies in which this equality of sexes exists already are the Royal Anthropological Institute, British Astronomical Association, Institute of Chemistry, Entomological Society, Geologists' Association, Linnean Society, London Mathematical Society, Royal Meteorological Society, Royal Microscopical Society, Physical Society, Röntgen Society, Royal Geographical Society, Royal Society of Arts, Royal Statistical Society, and the Zoological Society. The Royal Astronomical Society will thus be in good company if it decides that the time has come for the removal of the barriers by which women have been denied the privilege of being proposed for fellowship on equal terms with men.

DR. J. A. MURRAY has been appointed acting director of the Imperial Cancer Research Fund.

LORD FISHER OF KILVERSTONE and Vice-Admiral Sir Edmond J. W. Slade have been elected honorary members of the Institution of Petroleum Technologists.

IT is with much regret that we have to announce the death on Saturday, January 23, after a brief illness, of Mr. F. W. Rudler, for many years curator of the Museum of Practical Geology at Jermyn Street.

IT is announced in the issue of *Science* for January 15 that the Rockefeller Institute for Medical Research will receive 40,000*l.* under the will of the late Mr. Henry Rutherford, for cancer research work.

PROF. ARTHUR KEITH has been granted leave of absence for six weeks by the Royal College of Surgeons for the purpose of delivering a course of five lectures on anthropology at the Western Research University, Cleveland, Ohio.

THE anniversary of the birth of Sir Francis Galton, Tuesday, February 16, will be celebrated as usual by a dinner and lecture. This year Prof. J. Arthur Thomson has undertaken to deliver an address dealing with some aspects of war and eugenics.

THE annual meetings of the Institution of Naval Architects will be held on Wednesday, March 24, and the following day, in the hall of the Royal Society of Arts, John Street, Adelphi, W.C. The Marquis of Bristol, R.N., president, will occupy the chair.

WE learn with regret through a message received from the council of the Imperial Society of Naturalists, Moscow, of the death, at sixty-eight years of age, of Dr. Nicolas Oumoff, president of the society, and professor of physics in the Imperial University of Moscow.

THE gold medal of the Royal Astronomical Society has been awarded by the council to Prof. A. Fowler for his spectroscopic investigations of sun-spots, stars, and comets, and for his successful interpretation of cosmic phenomena by means of experiments in the laboratory. The presentation of the medal will be made at the annual general meeting of the society on February 12.

DR. TOKUTARO ITO, of Tokyo, has written to Lady Hooker to inform her that her distinguished husband —the late Sir Joseph Dalton Hooker—"has been recently selected by the contemporaries in Japan, as one of the twenty-nine heroes of the world that modern time has produced." We wrote to Dr. Ito a few weeks ágo to ask for a copy of the complete list of men thus selected, and hope to be able to give the names before long.

THE Second Indian Science Congress, organised by the Asiatic Society of Bengal, was held at the Presidency College, Madras, on January 14–16, under the presidency of Surgeon-General W. B. Bannerman. The sections of the Congress, and their chairmen, were as follows:—Agriculture and applied science, Dr. H. H. Mann; physics, Mr. C. V. Raman; chemistry, Prof. P. C. Ray; zoology, Dr. N. Annandale; botany, Dr. C. A. Barber; ethnography, Mr. H. V. Nanjundayya; geology, Dr. W. F. Smeeth.

THE Institute of Industry and Commerce informs us that a committee representing chemical manufacturers and scientific societies has been decided upon and that a meeting of all concerned has been convened and will meet this week, at the offices of the institute, Exhibition Buildings, Aldwych Site, Strand, W.C., to consider the present situation. Chemical manufacturers who are interested can obtain permission to attend the meeting by making application to the secretary at the above address.

THE rumoured death on the field of battle of Robert Douvillé is confirmed by a note in the *Revue critique de Paléozoologie* just received. The young *chef des travaux* at the Ecole des Mines had published a series of valuable studies on ammonites, of particular interest from his attempt to explain their phenomena of descent with modification on the principles of advanced biological theory. His colleagues in this country will feel much sympathy with his distinguished father, Prof. Henri Douvillé, and will lament a great loss to the science of palæontology.

AT the annual general meeting of the Royal Meteorological Society, held on January 20, the council, in its report, referred to the various investigations and work carried on by the society, including the researches in the upper atmosphere, the collection and discussion of phonological observations, the arrangements for the preparation of a climatological atlas of the British Isles, and the delivery of popular lectures on meteorology. Capt. H. G. Lyons was elected president, and Mr. F. Campbell Bayard and Commander W. F. Caborne secretaries, for the ensuing year. The new members of council are:—Mr. J. S. Dines, Mr. A. P. Jenkin, and Sir J. W. Moore.

A MEETING of the General Organising Committee for the International Botanical Congress, which had been arranged to be held in London next May, took place at the Linnean Society's rooms on Thursday last, January 21. A report was given of the work of preparation which had already been carried out by the executive committee, and the members were asked to consider the present position. The two following resolutions were carried:—(1) That the congress be not held in 1915; (2) that the present executive committee continue to act so long as necessary. The committee was strongly of opinion that a meeting of the congress in London should not be abandoned, and the suggestion was made that it might take place at the next quinquennium, in 1920. But it was agreed that nothing definite could be settled at the present time, and the following resolution was passed:—"That the executive committee be authorised to convoke a meeting of the general committee at some future date to consider the date of the congress." It was also decided that in the meantime the general committee be called together once a year.

FROM a letter received by Messrs. L. and H. Hagenbeck, of Hamburg, from Dr. Bultikofer, director of the Rotterdam Zoological Garden, and published in *Science* of January 15, we learn the following news relating to the Antwerp Zoological Garden:—All the bears in the garden were shot prior to the bombardment. The large feline carnivora were put into strong transportation cages and removed to the rear of the garden, also prior to the bombardment, while the small felinæ were transferred to cages in the cellars of the Festival Building. A few days before the surrender of the city, when the heavy cannonading started fires in all parts of the city, which could no longer be put out in consequence of lack of water, the large carnivora were likewise shot by resolution of the board of directors, but contrary to the director's advice. None of the other animals were killed, with the exception of a few venomous snakes. During the bombardment only one shell dropped into the garden, striking the ground in the open space for the turtles, where it fortunately did no material damage.

THE new building on Tower Hill of the Institute of Marine Engineers is illustrated in *Engineering* for January 22, and was inaugurated by the president of the year, Sir Archibald Denny, on Wednesday last week. The president urged that the institute should take up as a study how information might best be gathered and transmitted to the designers, and emphasised that such information should be as accurate as possible in order to be of service. So convinced is Sir Archibald of the value of short memoirs on sea experience that he has put at the disposal of the council a sum of money, the interest on which will enable it to distribute prizes for the best memoirs each year. The membership of the institute is now nearly 1500, and the new building includes a spacious lecture-room, library, reading-room, various social rooms, and the usual offices. The institute has done good work in the past in the way of bringing marine engineers together for the interchanging of experiences, and on the lines suggested by Sir Archibald Denny should be capable of extending its usefulness greatly.

IN July, 1912, a Russian expedition, under Lieut. G. Brussilov, left Petrograd for the Arctic. It was intended to winter in the Katanga or some other Siberian river, and then to complete the north-east passage (which, it is curious to recall, was yet to be accomplished by a Russian expedition), carrying out geographical and ethnological research. Another expedition, under Rusanov, started for these seas in the same year, and anxiety has been felt about both, in the absence of any news save rumours of a wreck at the mouth of the River Pechora. Captain Sverdrup was therefore dispatched in command of a relief expedition on the *Eclipse,* and it was reported last September that he himself was in difficulties, the ship being ashore near the mouth of the Ob. He was fortunately encountered by another vessel, and the *Eclipse* was towed off and proceeded. It is now announced, in messages from Petrograd, that she is in winter quarters in lat. 74° 45′ N., long. 92° E. On existing maps this position falls well inland in the Taimyr Peninsula, so that it may perhaps be assumed that she has found a berth in a bay on this coast. It does not appear that the search has yet succeeded.

SOME interesting particulars of the life of Dr. J. Muir, the widely known naturalist, whose death was announced in NATURE of December 31, are given in the *Scientific American.* John Muir was born in Dunbar, Scotland, April 21, 1838, and went to the United States when 11 years old with his parents, who settled in the wilderness of Wisconsin, where later he studied in the University of Wisconsin. His love of nature induced him to take up a wandering life, during which he covered much of the territory of the South-west and West, constantly increasing his knowledge of natural history, as well as allied sciences. About 1876 he joined the United States Coast and Geodetic Survey to enable him to extend the field of observations, and covered great sections of Alaska. The great Muir Glacier bears his name. He was one of the party that went in search of De Long and the lost *Jeanette* expedition, and also of the Corwin expedition, during which he had an opportunity to study the Glacier formation of the Bering Sea, and the coast of Siberia, and later went to Switzerland and Norway for purposes of comparison. Besides being a naturalist he was an able geologist, explorer, artist, and philosopher, and in his younger years showed that he was a clever inventor. He was widely known as the "Guardian of the Yosemite" and the "Naturalist of the Sierras" from his intense interest in those regions, and he did much for the preservation of the national forests and parks.

MR. T. F. BURTON has succeeded Mr. Watson Smith as editor of the Journal of the Society of Chemical Industry, and the first issue of the journal under his editorship is before us. No other journal can have so great an influence upon the chemical industry of the United Kingdom as that issued fortnightly by the Society of Chemical Industry; and at the present time, when a new editor is commencing his responsibilities, it is appropriate to point out that chemists will never again have so favourable an opportunity of asserting their influence on industry and gaining a greater hold in this country than during the next twelve months. The technical abstracts in the journal are very valuable, but perhaps the more purely scientific notes might be left to the Chemical Society. The space saved could be devoted to more general and commercial chemical topics, and so justify the journal as the organ of an industrial organisation. Though the papers communicated by members are not usually of a high standard, owing to some extent to the enforced secrecy about chemical processes, the current issue contains a contribution of striking merit by Mr. E. V. Evans, describing the solution of the all-important problem of the removal of carbon bisulphide from coal gas. More might be done, as indeed was attempted a few years ago, to publish summaries on the development or present position of certain selected branches of chemical industry. The opportunity to-day is a great one; it rests largely with the society whether the industrial chemists of the kingdom are to organise collectively to seize it, or whether action is to be left to the more progressive individual firms.

AT the end of last year Mrs. James Buckland sent us a letter which apparently had been issued to other periodicals at the same time, referring to the feather trade. In the course of this appeal to women to begin the new year with a resolve to abstain from the use of feathers in their millinery, the remark was made:—"The bulk of the plumage which comes into the London market—smuggled out of India and our Colonies for the most part—goes in a raw state to Germany, whence it is returned to this country made into hat decorations." As similar assertions relating to the importation of birds' plumage from India to Germany are often made, we have gone to the trouble of instituting inquiries with the view of obtaining accurate information upon this subject. We have been unable to find any particulars either in the official trade returns of Germany or of India as to the trade between these countries in birds' feathers. An examination of the German returns also shows that the imports of feathers into that country from the other British possessions are quite insignificant. The bulk of plumage of all descriptions, including ostrich feathers, comes into the London market, and the dyeing and mounting of these are done chiefly here and in France. This is the case with all high-class goods, but cheap articles of fancy feathers, wings, and mounts, have been bought here in the rough, sent to Germany, and then returned to us. There seems to be little justification for the statement that the bulk of the plumage in its raw state goes to Germany and is returned made into hat decorations, although some of it, exported from here, does find its way back again. Perhaps Mrs. Buckland, or someone else interested in the preservation of beautiful birds will furnish us with the definite information upon which the charge is based that the plumage trade is largely dependent upon the supply of birds' feathers to Germany from India and our Colonies. Unless such evidence is forthcoming we are of the opinion that by the publication of statements which do not admit of complete justification by fact, advocates of better protection of birds let their zeal outrun their discretion.

MR. A. SMITH, curator of the City and County Museum at Lincoln, has issued at the price of one penny a useful catalogue of the collection of implements of the Stone age. From Lincolnshire only one Palæolithic implement, now in the British Museum, is recorded, but the local museum possesses a good collection of Neolithic implements discovered in the county. Most of these are the gift of the Rev. Canon A. Rowe, augmented by a series recently presented by the authorities of the British Museum.

THE December issue of the *National Geographic Magazine is* devoted to the Nearer East. The most important contribution is that by Frederick and Margaret Simpich, under the title "Where Adam and Eve Lived," in which the scenery, city, and rural life of Bagdad and its neighbourhood are described and illustrated by a collection of admirable photographs. Mr. Simpich, in a second article, describes an adventurous trip to the little-known Nedjeb, "the Shia Mecca," where the fanaticism of the people is readily excited against Christian visitors. The writer had a narrow escape from attack when he attempted to examine the Abbas Mosque, the inner glories of which no Christian has ever seen.

THE report of the Bristol Museum and Art Gallery for 1914 is a record of steady progress, but the death of Lady Smith, of Ashton Court, deprived it of one of its most generous benefactors. During the year the director accompanied the British Association to Australia and procured a good collection of corals and marine invertebrata from the Great Barrier Reef. The great Watkins collection of Gloucestershire insects, including some 13,000 specimens, has been remounted and classified, and the other collections have been widely extended. The museum is largely used by students, and the authorities have made an important new departure by deciding that research work upon the museum collections or in the field shall in future be a definite part of the duties of the museum assistants.

WE have to acknowledge the receipt of the *Aarsberetning* of the Norske Meteorologiske Institut for the financial year ending June 30, 1914. The records of 507 stations are included, some of which, however, contain much fuller statistics than others.

IN No. 4 of vol. ii. of the *Children's Museum News* reference is made to a special case of the influence of the museum on the mind and pursuits of a boy, and thus of his whole future career. Although his family were all engaged in business occupations, he became deeply interested in wireless telegraphy, and now, after a special course of instruction, hopes to graduate in electrical engineering. "What the Children's Museum has done for this boy is typical of what it is constantly doing in a greater or less degree for other children." The number of visitors in October last was 4729—an increase of 1033 over the corresponding month of the preceding year—and in November 4864.

THE Board of Agriculture and Fisheries has issued a compendium of regulations for the show of thoroughbred stallions, suitable as sires for half-bred horses, to be held at the Royal Agricultural Hall, Islington, on March 2 and 3. The show is in connection with the Hunters' Improvement and National Light Horse Breeding Society. A cup for the champion stallion, to which a King's premium has been awarded, to be selected from those recommended for super-premiums, has been graciously offered by H.M. the King. It will be tenable for one year only; but a gold medal will also be awarded by the Board to the owner of the winning stallion. Fifty King's premiums, averaging a little more than 300*l*. each, are offered to owners who arrange for thoroughbred stallions to travel in prescribed districts. In addition, super-premiums, not exceeding a dozen in number, of the value of 100*l*., will be given for stallions of exceptional merit.

THE Earl of Cromer presided at the monthly general meeting of the Zoological Society, held on January 20, when the Council reported that 52 additions were made to the menagerie in December, of which 27 were presented, 18 received on deposit, and 3 in exchange, and 4 born in the Gardens. Among the more notable of these are a dwarf mongoose (*Helogale undulata*) from the Tana district of British East Africa, deposited; a golden-eared honey-eater (*Ptilotis chrysotis*) from Papua, presented by Mr. A. Ezra, and a pair of red-crowned fruit-pigeons (*Alectroenas pulcherrima*) from the Seychelles, received in exchange; the first and second of these being the first representatives of their kind received at the Gardens. The number of visitors to the Gardens in December was 17,279, a decrease of 12,541 as compared with the corresponding month of 1913. The total number of visitors in 1914 was 1,055,208, or 102,766 fewer than in the previous year; the total gate-money amounted to 24,666*l*., or 3557*l*. less than in 1913. The total number of additions to the list of Fellows was 305, or 59 fewer than in 1913, and 7 below the annual average for the last decade. Auditors were appointed to go through the Society's accounts for the past year on February 24 next.

AN important economic application of ecology is suggested by Prof. F. W. Oliver and Dr. E. J. Salisbury in a study of vegetation and mobile ground, as illustrated by the shrubby sea-blite (*Suaeda fruticosa*), reprinted from the *Journal of Ecology*, vol. i., No. 4. The authors give the results of their detailed and continuous observations on the distribution and manner of growth of this plant on the shingle beach at Blakeney Point, Norfolk, showing that where conditions permit its establishment on the lee edge of a beach it will, as the beach slowly travels over it, respond by continually growing to the surface, hence the plant disposes itself in longitudinal belts on the beach corresponding in establishment to periods of dormancy of the beach. By its great capacity for rejuvenescence and power of arresting the travel of shingle, and thus raising the height of a beach, Suæda would appear to be pre-eminently adapted for planting on shingle spits and similar formations with the object of arresting landward travel. The authors point out that as knowledge accrues of the detailed mechanism of accretion due to the establishment of plants on blown sand, tidal flats and shingle beaches, it will become possible to exert some degree of control over the form and distribution of the resulting topographical features, and they look forward to the time when, as an outcome of detailed vegetation studies of the kind here presented, the art of moulding the plastic coast line will develop into a recognised craft.

THE rainfall of 1914 is dealt with in *Symons's Meteorological Magazine* for January, and rather more fully in the *Times* of January 19, by Dr. H. R. Mill, Director of the British Rainfall Association. The results are given in anticipation of the more copious discussion which will appear some months hence. Of 5500 records some 3500 have been already received, and a representative selection of the stations has been used. The months of February, March, November, and December were wet, and of these February was the wettest in Ireland, and December in Great Britain. The rainfall of December is said to have been exceptional in all parts of the Kingdom, and especially so in the South of England. From April to October the rainfall was in general well below the average, and it is surmised that the dryness of this period was about as abnormal as was the great rainfall of December. In England and Wales the rainfall for the year was 106 per cent. of the average, in Scotland 102 per cent., in Ireland 106 per cent., and for the whole of the British Islands 105 per cent. The records of 57 years at Camden Square and 41 years at Slough show that no other December has yielded so large a rainfall, and it is suggested that it was not only the wettest December, but probably the wettest month on record for the southern counties. At Camden Square the rainfall for December was 25 per cent. of the annual fall for 1914. The map giving the December rains for the Thames Valley shows extensive areas with the measurement of 10 inches, whilst in the neighbourhood of Hindhead the rainfall for the month was 12 inches.

THE recent increase of the number of 10-candle-power pentane lamps sent to the Bureau of Standards to be tested, has led to a detailed examination of the conditions under which such lamps should be operated in America to give the most accurate results. A memoir on the subject by Messrs. E. C. Crittenden and A. H. Taylor appears in part 3 of vol. x. of the Bulletin of the bureau. It deals with the preparation and testing of the pentane, the ventilation of the photometer room, and the preparation and operation of the lamp, and shows how the candle-power of the lamp is affected by the pressure, temperature, and humidity of the air of the photometer room. In general the directions for use of the lamp are in agreement with those issued by the Metropolitan gas referees of London, but in some of the details the two differ owing partly to the greater humidity of the American atmosphere.

UNDER the auspices of the University of Tokio the hot and mineral springs of Japan are being tested for radio-activity, and reports by Messrs. S. Ono and H. Ikewti, on the springs of four districts appear in the Proceedings of the Tokio Mathematico-Physical Society for November, 1914. The measurements were made by the bubbling method, and give for the hot springs in the south of the province Higo values between 1·4 and $0{\cdot}3 \times 10^{-12}$ curie of radium emanation per c.c. of water, for the cold springs of the province Etigo the figures are 0·3 to 0·1 at Matunoyama, and 17·3 to 14·8 at Murasugi, and for those in the north-east of Sinano 0·16 to zero. In comparing these figures with 2×10^{-12} gram of radium which forms the average content of a gram of rock, it is to be noted that the curie is the amount of emanation in equilibrium with a gram of radium, and at normal temperature and pressure occupies 0·60 cubic millimetre.

AN important paper was read by Mr. E. Kilburn Scott before the Society of Chemical Industry on January 4 on a new electric furnace for the production of nitrates from the atmosphere. The author emphasised the immense importance, in view of the war, of manufacturing nitrates from the air by electric power, and described a new three-phase furnace which, it was claimed, has substantial advantages over the existing single-phase furnaces now in use on the Continent. Briefly, the new type of furnace consists of three electrodes, spaced 120° apart, consisting of ½-in. steel rods, bent at about 30° from the vertical. The top of the furnace, through which air is circulated, is a boiler with vertical copper tubes for the gases to pass through. The advantage of this system is that with a given periodicity of supply thrice as many arcs are formed in a given time as would be the case with single-phase. The three phases give a combined flame of conical shape which is hotter than if the same energy were expended in three separate furnaces, because the latter have only a single flat flame and the losses by radiation are much greater. The efficiency per unit cost of plant is much increased by the arrangement described, and the heat energy can be largely recovered by using the steam produced in the boiler to generate electricity, the combination thus working regeneratively. Owing to the increased temperature the yield of oxides of nitrogen, too, is largely raised under the new system of working. Since the Notodden factory was started the percentage concentration of nitric oxide has been doubled merely by making small modifications in furnace construction and in the rate of supply of air, but it is still under 20 per cent. The fact that it is so much lower than the value theoretically possible indicates that great improvements are still possible in the working details of the process.

ATTENTION was directed by French surgeons some time ago to the unusually high proportion of the French wounded suffering from tetanus, gangrene, and other forms of blood poisoning. In the *Comptes rendus* of the Paris Academy of Sciences for January 11 is a paper by M. Victor Henri which throws some light on the cause of this. From the results of the examination of a number of unexploded German shells, M. G. Urbain has been able to prove the presence of phosphorus. Common shell of 77 calibre and shrapnel shell mostly contain a large quantity of a violet-brown powder, smelling strongly of white phosphorus, and 97 per cent. of which consists of various kinds of phosphorus, the red variety predominating. In the common shell the phosphorus is contained in a cylindrical box, diameter 25 millimetres and height 60 millimetres, placed in a cavity behind the explosive. In the shrapnel shell, the bullets are placed in a cylindrical white metal box 65 millimetres diameter, and the space between the bullets is filled with the same violet-brown powder. The whole is rammed tight, so that the bullets, which are roughened, retain a certain quantity of the phosphorus. As a result, pieces of German shells and shrapnel bullets carry more or less phosphorus into a wound. This fact should be specially brought to the notice of surgeons, since phosphorus can produce a mortification of the tissues even with a shrapnel bullet, and micro-organisms, especially the anaerobic organisms, which produce tetanus and gas gangrene, find a favourable medium for their development and the wound may become grave. It is therefore advised that wounds produced by shrapnel and fragments of shell should be deeply incised and cleaned with the greatest care.

MESSRS. LONGMANS, GREEN AND CO. announce that from February 1 the complete list of publications of the Manchester University Press will be published by them throughout the world.

OUR ASTRONOMICAL COLUMN.

ANNUAL REPORT OF THE U.S. NAVAL OBSERVATORY.—The report, for the year 1914, of the superintendent of the U.S. Naval Observatory, is presented as Appendix No. 2 in the Annual Report of the Chief of the Bureau of Navigation, 1914. While the report itself only covers twenty pages, the contents are very concentrated, and cover a very large field of activity. The superintendent refers briefly to the distribution of time, the issue of the American Ephemeris and Nautical Almanac, the observations of sun, moon, planets, satellites, comets etc. Each of these subjects is more fully described in the subsequent paragraphs under the various sub-headings. Regarding the longitude determination between Washington and Paris by wireless signals, it is stated that the reduction of the observations is well advanced, and this will constitute the first direct determination between the Naval Observatory and Europe. Ten American observatories took advantage of the opportunity of using these signals and made the necessary observations to determine their longitudes.

THE APPLEY BRIDGE AEROLITE.—A description of the Appley Bridge meteorite (see NATURE, November 5, 1914, and January 7) sent to the Royal Astronomical Society by Messrs. W. C. Jenkins (Godlee Observatory) and E. C. Rhead, appears in the Monthly Notices of the Society for December, 1914. Of the recorded falls in Great Britain that of Wold Cottage is the only one of greater weight than the present one. Ultimate analysis showed silica, magnesia, iron, and alumina were the principal constituents; small quantities of sulphur, nickel, and phosphorus were found. Chlorine, sodium, potassium, calcium, strontium, and antimony were detected and lead was suspected. It is stated that a careful—chemical—search for titanium gave negative results. The question arises, was chromium specially looked for?

ANNUAIRE DU BUREAU DES LONGITUDES, 1915.—We have received a copy of this very useful publication, issued by the Bureau des Longitudes, Paris. The table of contents is, of course, parallel with that of the volume for 1913, that is to say, in addition to minor changes in the first section, the second section is made up of geographical and statistical tables, etc., in place of the chemical and physical data given last year. There is a noteworthy addition in the shape of a description of the constellations from the pen of M. G. Bigourdan, containing a list giving details of more than 400 of the brighter stars in 88 constellations. The usefulness of the list might have been increased by the addition of a column containing type of spectrum. A valuable essay (162 pages) by the same able author on the methods of testing mirrors and objectives forms the final section.

THE THEORY OF A SUNSPOT SWARM OF METEORS.—Prof. R. A. Sampson (Monthly Notices, Royal Astronomical Society, December, 1914) discusses some points in the theory that sunspots are produced by a bombardment of the sun by meteors of the Leonid swarm detached by encounter with Saturn. Two objections are advanced: first, that the conditions required by the hypothesis would require an improbable mass for the Leonids, and, secondly, that the orbit of the Leonids does not allow the required encounter of the swarm with Saturn. What is probably the more interesting outcome of Prof. Sampson's investigation is the deduction of a new date for the capture of the Leonids. It is shown that there are three dates, all more recent than Leverrier's (A.D. 126), in which the critical conditions for capture obtained; one of these, A.D. 885, comes a little before the earliest recorded shower (A.D. 902), and accordingly is considered the more probable date.

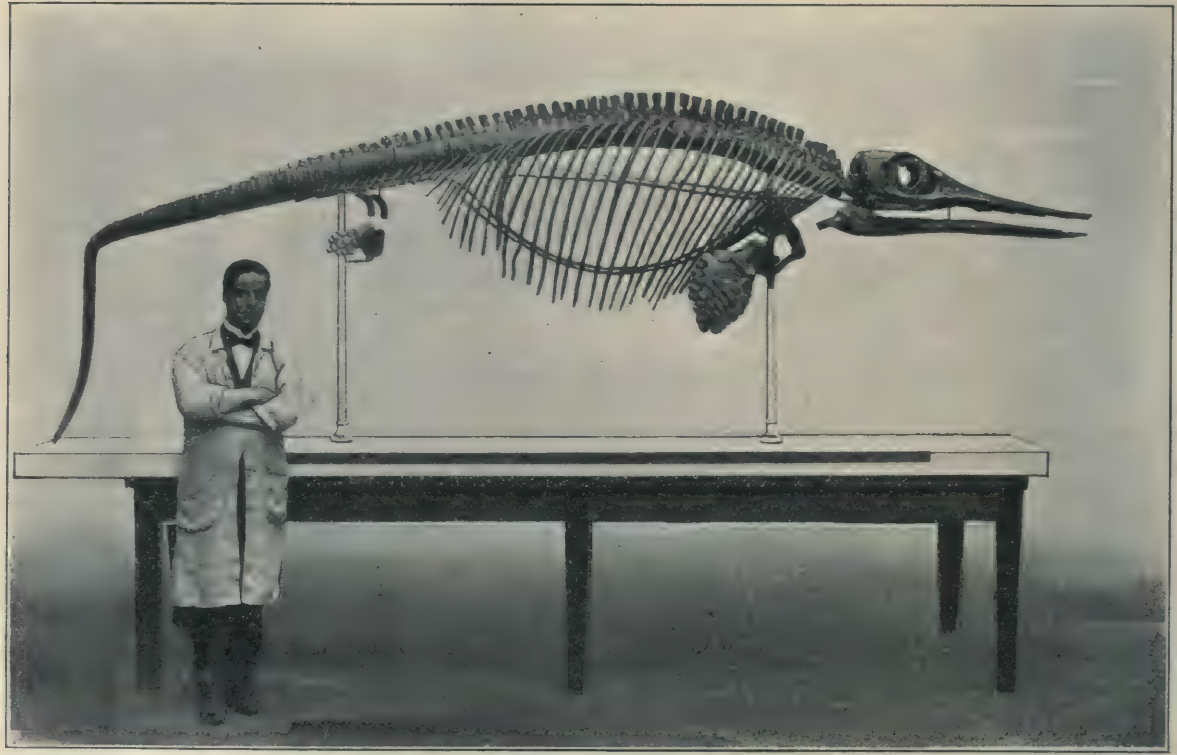
THE RESTORATION OF AN ICHTHYOSAUR.

SOME three-quarters of a century ago the late Sir Richard Owen directed attention to the very frequent occurrence in the flattened skeletons of ichthyosaurs from the Lias of Whitby and Lyme Regis of a sudden flexure in the vertebræ of the tail at a distance from the tip of about one-fourth the total length. This flexure, he argued, must have been due to the presence of a terminal tail-fin, placed vertically, like that of a fish, although not fish-like in structure. The truth of this has been made apparent, not only by the impression of the soft parts in some of the ichthyosaurs from the Lias of Holzmaden, but likewise by the skeletons of their successors disinterred by the Messrs. Leeds from the Oxford Clay near Peterborough, all the latter exhibiting a structural modification at the point in question. Of these wonderful Oxfordian skeletons a reconstructed example, of which we are enabled to give a figure, has recently been set up in the fossil reptile gallery in the Natural History branch of the British Museum, and is believed to be the first entire articulated specimen placed on exhibition. It belongs to the big-eyed, broad-paddled, and practically edentulous group constituting the genus Ophthalmosaurus, of which it represents the species known as *O. icenicus*. As mounted, it measures a little more than 13 ft. in total length, and carries about fifty pairs of ribs, of which the first half-dozen or so are crowded together in order to enable them to underlie the scapulæ.

The work of fitting together and mounting the *disjecta membra* of this skeleton was one which called into play all the skill of the articulators of the geological department, to whom great credit is due for the accomplishment of such a difficult task.

A point of special interest in connection with these toothless ichthyosaurs is the nature of their food, which was almost certainly different from that of their strongly toothed Liassic precursors, which appear to have been less well adapted for a pelagic life. It is not that the heavily armoured ganoid fishes of earlier formations had died out, as witness the presence of Lepidotus in the Oxfordian; and it may be that the ichthyosaurs of that epoch fed on belemnites instead of fish. If this be so, the Cretaceous toothless pterodactyles may likewise have made an analogous change in their diet, as compared with that of their well-toothed ancestors, only in their case it may have been merely from hard-scaled to soft-scaled fishes.

R. L.



Skeleton of *Ophthalmosaurus icenicus* from the Oxford Clay exhibited in the Geological Department of the British Museum (Nat. Hist.). Reproduced from the *Museums Journal.*

DEVELOPMENT OF THE CULMS OF GRASSES.

An important paper by Mr. R. S. Hole, forming Forest Bulletin No. 25 of the Indian Forest Research Institute, deals with the development of the culms of grasses. The author points out that the generalisation, based upon the study of grasses and cereals of temperate climates, that the culms are annual does not hold good in the case of various economically important species which are dominant in the savannah lands of Indian forests; hence the discovery of a method by means of which the age of the culms of any particular species can be readily determined is a matter of practical importance bearing directly on such questions as the selection of the best rotation to adopt in the case of grasses worked for paper pulp or the liability of certain species to fire damage at particular seasons. The observations recorded in this paper are of general interest, as the plant chosen for investigation was wheat, and the following are the chief results obtained.

Grass culms show in general two periods of growth—a preparatory period characterised by short internodes carrying scales or under-sized leaves, and a subsequent period of vigorous growth characterised by long internodes carrying well-developed leaves. In the average primary culm (1) the same number of leaf-bearing internodes is produced in these two stages, but the period of preparatory growth is approximately three-fourths of that of vigorous growth; (2) the average number of long internodes produced is approximately equal to the number of months in the period of vigorous growth, and this number is practically the same whether calculated from the primary culms alone, from the axillary culms alone, or from a mixture of these as found in the final crop. In the older axillary culms (1) both growth periods, but more especially the preparatory period, are shorter than those of the primary culms, and there is little difference between the two classes of culms as regards the date of ripening grain; (2) the number of leaf-bearing short internodes is approximately half the number of the long internodes, and the preparatory period of growth is approximately half the vigorous growth period. The author thus obtains for both annual and perennial grasses the generalisation that the average number of leaf-bearing long internodes produced in a culm—that is, excluding the apical segment terminating in the inflorescence—is approximately equal to the number of months comprising the period of vigorous growth.

F. C.

PARIS ACADEMY OF SCIENCES.

The Bonaparte Fund.

THE committee appointed to deal with the allocation of the Bonaparte Fund for the year 1914, has made the following proposals, which have been unanimously adopted by the academy:—

(1) 2000 francs to Pierre Breteau, to enable him to pursue his researches on the use of palladium in analysis and in organic chemistry.

(2) 2000 francs to M. Chatton, to give him the means of continuing his researches on the parasitic Peridinians.

(3) 3000 francs to Fr. Croze, to enable him to continue his work on the Zeeman phenomenon in band and line spectra, the amount to be applied to the purchase of a large concave grating and a 16-cm. objective.

(4) 6000 francs to Dr. Hemsalech, for the purchase of a resonance transformer and a battery of condensers for use in his spectroscopic researches.

(5) 2000 francs to P. Laïs, director of the Vatican Observatory, to assist in the publication of the photographic map of the sky.

(6) 2000 francs to M. Pellegrin, to facilitate the pursuit of his researches and the continuation of his publications concerning African fishes.

(7) 2000 francs to Dr. Trousset, to aid him in his studies relating to the theory of the minor planets.

(8) 2000 francs to M. Vigouroux, to assist him in continuing his researches on silicon and its different varieties. These researches, in which it is necessary to make use of hydrofluoric acid, necessitate the use of expensive receivers.

(9) 3000 francs to M. Alluaud, for continuing the publication, undertaken with Dr. R. Jeannel, of the scientific results of three expeditions in eastern and Central Africa.

(10) 9000 francs to be divided equally between MM. Pitard, de Gironcourt, and Lecointre, all members of the scientific expedition to Morocco organised by the Société de Géographie.

(11) 2000 francs to Prof. Vasseur, to assist him in his geological excavations in a fossil-bearing stratum at Lot-et-Garonne.

(12) 3500 francs to Dr. Mauguin, for the continuation of his researches on liquid crystals and the remarkable orientation phenomena presented by these singular bodies when placed in a magnetic field. The grant will be applied to the construction of a powerful electromagnet.

(13) 2000 francs to Dr. Anthony to meet the cost of his researches on the determinism of the morphological characters and the action of primary factors on the course of evolution.

(14) 4000 francs to Prof. Andoyer, a first instalment towards the cost of the calculation of a new table of fifteen figure logarithms.

(15) 4000 francs to M. Bénard, to enable him to continue his researches in experimental hydrodynamics on a large scale.

(16) 2000 francs to Dr. Chauvenet, to enable him to continue his researches on zirconium and its complex combinations.

(17) 2000 francs to Prof. François Franck, for the chronographic study of the development of the embryo, with special examination of the rhythmic function of the heart.

(18) 2000 francs to Prof. Sauvageau, for the pursuit of his studies on the marine algæ.

PROBLEMS OF PRODUCTION IN AGRICULTURE.[1]

THE fact that this address is to be delivered in the capital city of a State in which semi-tropical, and even tropical, conditions prevail, suggests some consideration of the future of countries in which vegetative development, and therefore the production of food, can attain such a level as is possible here.

At the outset let me remind you of two prime facts in the natural history of man. In the first place all civilisation is based upon food supply; no other industry is creative, and the wealth of a community might almost be measured by the amount of time that remains at its disposal after it has secured, either from its own land, or by exchange, the food it needs to live upon. Secondly, we must look forward at no very distant date, as the life of nations goes, to the exhaustion of those capital stores of energy in the world—coal and oil—on which the current industrial system is based. How long the stores may last is a matter of dispute, but 500 years is a liberal estimate, and we can be pretty sure, in a world in which prophecy is notoriously unsafe, that nothing remains to be discovered which can take the place of those savings from the energy of bygone epochs that are represented by coal and oil. With the passing of industrialism the importance of agriculture will grow, and while the world as a whole will still be able to support the same number of people as are fed by agriculturists of to-day, great readjustments of the population will have to be effected, according to the productive powers of the land in each country. Should population continue to increase, and the spread of organised and stable government ensures that it will grow, there must come a demand for the better utilisation of the land and for a higher production of food than at present prevails; indeed, even in the last few years symptoms of this increasing demand for food have been in evidence. Let us see what the land can be made to do at the present time in the way of supporting population, and for that we must turn to the East, where long experience of the art of intensive agriculture goes hand in hand with an optimum climate and a population of maximum density. Rural Japan is reported to carry a population of 1922 to the square mile, entirely supported by agriculture, but maintaining in addition its quota of officials and industrials. Even this number is exceeded in China, where a farm of two and a half acres will support a family of eight to ten people, and where, in some special cases, as on the island of Chungming, the population living wholly on the land may rise nearly to 4000 per square mile. Compared with these figures the density of population on Western land is trifling. The United States is said to maintain no more than 61 per square mile of its cultivated land, England something above 90, Ireland about 120, and Belgium, perhaps the most intensely cultivated of European countries, not more than 200 per square mile of cultivation. Now, these enormous densities of rural population are accompanied by a very low standard of living; the people, if strong and healthy, exist on the very margin of sustenance. To take a cash standard, an experienced rural labourer in China cannot command more than 6d. a day, on which he will support a family. But for this small pay of 6d. a full day's work will be obtained; indeed, such a day's work as the white man would find it almost impossible to give under the climatic conditions prevailing.

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[1] Part II. of the presidential address delivered before Section M (Agriculture) of the British Association at Brisbane, by the president of the section, A. D. Hall, F.R.S. Part I. appeared in NATURE of October 8, 1914.

Such a state of continuous toil seems to be the necessary outcome of an individualistic system of farming in countries with no great industrial outlets, where the pressure of an increasing population results in continued subdivision of the land. Of its kind Chinese agriculture is magnificent, so far as one can judge from the accounts; the land is made to do an extraordinary duty, bearing two or three full crops a year; waste is non-existent, and long experience has taught the farmers to anticipate in practice some of the most recent discoveries of science in the way of conserving and recuperating the fertility of the soil. Though no statistics are available, the land seems to have been raised to its highest level of productivity per acre, just as it has attained its maximum population-carrying capacity.

Now the Australian, like other farmers in new countries, is often reproached for the low yields per acre that he obtains—10 to 15 bushels of wheat per acre, as against 32 in England, and rather more in Holland and Belgium. Unfavourable as is this comparison of Australia with Europe, still greater appears the superiority of China and Japan, though it cannot be reduced to statistics. But the Australian quite rightly replies by setting up another standard of comparison; not the production per acre, but the production per man is his criterion, and on this basis the Australian farmer takes a very high position indeed. Against the productivity of the land when labour is unlimited he opposes the ideal of the productivity of the man when aided by machines and unlimited land.

Organised large-scale farming supports far more people than the labourers actually employed on the land; it buys machines and raw materials like fertilisers, it pays rent and makes profits, all of which go to the support of other people, who are at bottom fed and maintained by the production from the land. I have calculated that the most highly cultivated farm with which I am acquainted in Britain, a farm selling merely meat, potatoes, and corn, would actually support people at the rate of more than 1000 per square mile, if they were to live at such a low subsistence level as that of the Oriental small farmers. The standard of living that in fact prevails is, of course, very different, but, nevertheless, when all the exchanges of commodities and services against food are completed, that square mile of highly organised farm land is the ultimate support of a population comparable with that resident on Eastern land even though the number of people actually tilling the soil is small enough.

But even if the number of people maintained by a given area under Western conditions is far greater than would appear from those employed in cultivating the soil, there must come a time when the pressure of an increasing population will necessitate a much higher agricultural efficiency in the way of production of food per acre. Now, if we attempt to meet this pressure by subdivision of the land, attracted by the specious appearance of a large population supported on the soil, the operation of competition will force them down to such a low standard of living as we find in China and Japan. A large number of men on the land does not necessarily make for more food for the community, because in practice we find that the standard of cultivation and production per acre of the small holder is actually below that of the larger farmer in the same class of business. For example, one thousand acres might be cultivated by twenty men, so as to produce as much food as if it were divided up and made to carry 200 men on five acres apiece; the community, considered as a whole, is richer in the former case by the labour of 180 men, labour that can be devoted to the production of other articles which the small holders would have to go without. Clearly, if twenty men can grow a maximum of food on the thousand acres, it is mere waste to employ 200 men about it, though, at first blush, in the latter case, the land seems to be carrying ten times more men. The only question is whether the intensive cultivation, which is more or less forced upon the two hundred holders of five acres, can be obtained when the area is cultivated, as a whole, by only twenty men. There is no lack of evidence that it can, but the means by which such large-scale farming can in the end beat mere grinding human labour, is by utilising to the full all the resources of science, machinery, and organisation. In fact, when the world becomes fully populated, the application of science to agriculture is the only method by which the community can be saved from falling into the Oriental condition of a community of labourers working incessantly for a bare subsistence.

Now, we may ask ourselves what remains for science to do towards the improvement of agriculture. Practically everything. Agriculture is half as old as man; centuries of experience, of trial and error, of slowly accumulated observations, are bound up in the routine of the commonest cultivation of the soil; the science applied to agriculture is at the outside little more than a century old, and so far has only partially succeeded in explaining and justifying existing practices. It is still in the reign of first approximations to the truth; these specious first approximations which so regularly break down when applied to the real thing on a large scale, where the second or even the third terms really dominate the issue. The farmer is fond of reproaching the scientific men with the discrepancy between theory and practice; there should be none if the theory is complete, but in such complex matters as the growth of plant and animal we are yet very far from being able to bring into account all the factors concerned. A shipbuilder, for instance, having built to a certain speed and measured off his distance on the map, may reckon on making his port on a certain day; he finds himself wrong, because of the existence of a current which takes a knot or more off his speed. His theory was not wrong, only incomplete. Fuller knowledge may map the currents and their velocity, but even the new calculation may be put out by some unexpected weather factor. Now the growth of a plant is determined by an infinitely more numerous and less measurable series of factors than the speed of a ship, small wonder then that the calculations based upon them are apt to be so erroneous.

Imperfect as is our knowledge, yet we have progressed far enough to see in what directions fruitful work may be done, and may plan our campaign of research. In connection with the soil, for example, the big problem is probably the prevention of the waste that goes on at an increasing rate as the soil becomes more enriched by the accumulation of organic matter. Many soil bacteria, as we know, deal with the compounds of nitrogen in the soil so as to set free nitrogen gas from them, all of which actions are sheer waste of the most valuable constituent of the soil, and to such an extent does this change take place that we cannot, as a rule, expect to recover in the crop more than one-half of the nitrogen contained in farmyard manure applied to the soil. Where the soil is rich, and a high level of production is being arrived at, the percentage of waste may be even greater; for example, on the Rothamsted wheat plot, which has received 14 tons of dung every year, only about one-quarter of the nitrogen applied in the manure has been recovered in the crop, and less than a quarter remains stored in the soil. When a hundred pounds of nitrate of soda per acre is applied, nearly the whole of the nitrogen it contains will be recovered in the increased crop; with an application of 200 lb. there may be a waste of 25 per cent. of the nitrogen, with still greater losses as the application is increased. The loss is not due to mere washing out of soluble materials, because it is greatest when the nitrogen is applied in organic manures. Under existing conditions, high productivity in the soil is associated with a high rate of waste, and nowhere is this more marked than when cultivation is carried on under tropical conditions, so that one of the chief difficulties of tropical and semi-tropical agriculture is to maintain the stock of humus and nitrogen in the soil. An illustration of the waste that so often goes on in the soil is furnished in the practice of the cultivators under glass in England. For the growth of cucumbers and tomatoes they are in the habit of making up a very rich medium, half soil and half dung, but after a very few crops they are no longer able to use this mixture profitably, but must throw it away and renew their beds, though the rejected soil is still extremely rich in the elements of plant food. The recent investigations at Rothamsted have shown that the fertility of this "sick" soil can be restored by merely heating it for an hour or two to a temperature approaching that of boiling water, the cost of which operation is considerably less than that of renewing the soil. In this case the uselessness of the sick soil appears not to be due to the destruction of the nitrogen compounds, but to their retention in a condition unavailable for the plant. The nitrogen compounds have to be broken down to ammonia or nitrates before they can feed the plant; this process is effected by certain groups of bacteria, the numbers of which are limited in the sick soil by the excessive development of another group of soil organisms—protozoa, amœbæ, etc., that feed upon the bacteria.

We are only just beginning to take stock of all the changes in the soil materials that are effected by living organisms, some necessary, some competitors with the plant, some wasteful; the ultimate problem is to bring these processes under control in the field as well as in the laboratory. The antiseptic treatment of the land at large, after the fashion we can now clean up soils in pots, may seem an impossible dream, but not more impossible than the production of a heavily yielding weedless field of wheat would have seemed to primitive man. Already much may be done to set up a better micro-flora and -fauna in the soil by improving its physical conditions. The good effects of such processes as liming and drainage are largely due to the encouragement that is thereby afforded to the valuable organisms. Soil inoculation with such necessary bacteria as those which fix nitrogen when living in the nodules on the roots of leguminous plants has been widely attempted, but with very little practical success. The failures have generally been due to the fact that soils from which the nodule organism is absent are without it because of some chemical or physical defect; it is not sufficient merely to seed it with the organism, the soil itself must first of all be brought into a state to maintain its existence. The best of grass seeds would be wasted unless the land on which they are sown is first made clean and fertile. The amelioration of soils on their physical side, by bringing clay and silt to the sands, sand and coarse particles of various kinds to the clays, will eventually be taken up on a great scale, now that engineering has made it possible to move earth wholesale by cheaper means than by primitive spade and cart. I have seen a cold clay carrying miserable pasture converted into good market garden land by nothing more than the application of a thick layer of town refuse and ashes; only organisation is needed to make such processes economic, even when the immediate, and not the ultimate, return is reckoned.

From the point of view of manures we shall have to look forward to an ultimate scarcity of nitrogenous fertilisers; the exhaustion of sodium nitrate is only a question of time, the present sources of sulphate of ammonia will disappear with the coal, and the water power which is now giving us nitrate of lime and cyanamide will then be too precious to be used in making fertilisers. Even if the new process for the synthesis of ammonia proved as economical as is expected, we ought still to depend upon the natural processes of nitrogen fixation, and make the farm self-supporting as regards nitrogen at a high level of production. The clover crop in the rotation usually followed in England will, under present conditions, gather in enough nitrogen for the growth of about twenty-four bushels of wheat to the acre, an equal quantity of barley, and twelve tons of turnips. How can we similarly maintain production at a level of 40 bushels of wheat, with other crops in proportion, yet without any nitrogenous fertiliser from outside?

A more immediate problem of the same kind is before the investigator; all around our great cities exist great market gardening industries, which have been built up by means of the cheap supplies of stable manure that were to be obtained therefrom. The market gardener close to London and as far afield as Bedfordshire, rendered thin sands and gravels fertile by using 40 tons or more of London dung every year, but the advent of the motor-car has curtailed, and will eventually put an end to, that supply, in which case how is the market gardening to be carried on? Nitrogen compounds and the other bare elements of plant food can be bought, but humus is also necessary to get these thin soils to yield a proper growth; what needs to be worked out is the cheapest and most effective way of utilising leguminous green crops and the other nitrogen-fixing organisms of the soil to maintain the fertility of such land, keeping in view the fact that it cannot be thrown out of productive cultivation for any length of time. What is needed is not a field experiment merely, but a discussion of a whole system of cultivation on the economic as well as on the scientific side. This suggests the general consideration that economic research in agriculture is still in its infancy. How often do we find close at hand two farmers, both good practical men, with entirely divergent views on the rotation to follow or the management of their stock, one swearing by early maturity and a forcing diet, the other by cheap if slow production. The advantage of one system over the other is not a mere matter of opinion and personal idiosyncrasy, it is possible to reduce it to terms of pounds, shillings, and pence. The prime necessity is the application to farming of a system of costs book-keeping, such as prevails in a well-organised business. It is possible to obtain such figures from a farm; the method is as yet perhaps too complicated for the ordinary farmer to follow, but as an instrument of investigation in the hands of a teacher at one of the agricultural colleges it may be made to yield results of great value both to the individual farmer and to all those who have to take more general views of agriculture.

Returning to the purely scientific aspects of research, the whole of existence is based upon the fundamental process by which the green leaf utilises the energy of the light falling upon it to split up the carbon dioxide of the atmosphere and transform it into those fundamental carbon compounds—sugars, starches, etc., which build up the substance of the plant. The animal creates nothing; it is only a transformer, and rather a wasteful one at that, of the compounds initially built up by the plant. Now, though the leaf is thus the prime creative force, it is yet a comparatively ineffective machine for dealing with the energy contained in the light, for it does not succeed in storing up in the shape of plant materials it produces as much as 1 per cent. of the energy that falls upon it as light, and in bright, tropical light the percentage utilised is even less. A steam engine, given a certain amount of energy in the shape of coal, turns out again about one-seventh of it in the shape of useful work; a gas or oil engine is an even more effective transformer. Can the duty of the leaf be increased so that it shall effect a greater production of dry matter for the amount of light energy it receives? We know very little as yet about even the sequence of chemical changes in the leaf beyond the fact that we begin with carbon dioxide and water and end with oxygen and some sort of sugar, we are beginning to acquire knowledge as to the extent the rate of change is affected by the supply of light, carbon dioxide, and water, and by the temperature. But we have now many examples in chemistry of reactions being speeded up or rendered more complete by means of some adjustment of the external conditions, so it is perhaps not too much to expect that this fundamental process of carbon assimilation may also be tuned up until the leaf becomes of greater efficiency than at present in producing tissue from the materials and energy supplied to it.

Probably the most immediate successes are before the plant-breeder, now that the application of the Mendelian theory has provided a method which renders both speedy and certain the processes of crossing and selection whereby the practical men of the past, working almost at haphazard, have already effected such enormous improvements in our cultivated plants. Among cereals, the qualities in demand, qualities which we know to be obtainable, are resistance to disease, stiffness of straw, and a large migration factor. We want to get rid of the plant-doctor, as it were; spraying and other prevention or curative treatments are both costly and of limited efficacy; the desirable method is to keep the plant free of disease by means of a naturally resistant constitution, and by establishing healthy conditions of soil and nutrition. As to stiffness of straw, the incapacity to stand up is probably the chief cause which limits the yield of corn crops in Britain wherever the farming is high. When a man keeps much stock, and buys cake either for his bullocks, or to feed to his sheep on the turnips, the land becomes so rich that the first corn crop will only stand up under exceptionally favourable weather conditions, and the farmer, so far from buying more fertiliser, cannot take full advantage of what is already in the soil. The land is often rich enough to yield 60 bushels of wheat to the acre, but it is exceptional that a crop of such weight will stand up so that it can be harvested by a self-binder. Mr. Beaven, in this section, has already dealt with migration; clearly it is a matter of great importance to the plant-breeder. Though the details have only been worked out for barley, the different varieties of any cultivated plant, wheat, for example, are very much alike as regards their gross productive power—*i.e.* the whole material grown weighs much the same in a dried condition. Even different crops produce much the same amount of dry matter when grown under the same conditions, this gross productive power being in all cases the similar product of the environment—*i.e.* the result arising from the supply of food, water, light, temperature, etc. But granted that the different crops possess this same gross productive power, then their comparative usefulness depends upon the greater or less completeness with which they transform the crude material into products that may be used as food for man. In the cereals, for example, we want as much as possible of the original stuff manufactured by the leaf to be migrated later in the plant's life into the seed; of the total weight of the crop we want the largest possible proportion to be high-grade grain and not low-grade straw. Mr. Beaven has shown that the various varieties of barley do differ constantly in their proportion of grain to straw, and as, without doubt, the same differences hold for other crops, this is a matter which must be watched by the plant-breeder.

Cereals are not, however, the only materials upon which the plant-breeder has to work; indeed, they are already among the most advanced of our domesticated plants, and the other farm crops require great improvement before they reach the level of wheat and oats. Sugar beet affords a most interesting case; by selection the percentage of sugar contained in the root has been raised by one-half. The total amount of material grown per acre remains, however, much where it was, because of the difficulty, the impossibility, in fact, as yet, of testing the yielding capacity of a seedling root whereas its sugar contents can be measured with ease. The same difficulty is seen among our other root crops; such improvement as has been effected in the mangold, turnip, etc., has chiefly been in the shapeliness and habit of growth of the root, these alone being the characters that are apparent to the selector dealing with a group of seedlings. To some extent these may be correlated with total yield, but how little may be judged from the fact that the long red mangold, one of the very oldest varieties, is still the largest producer of dry matter and sugar per acre. The comparative yield of cereal varieties may be tested by the growth of a few hundred plants under rigorous conditions; some similar method will have to be worked out for root and fodder crops, before the plant-breeder can make much headway with them. Granted such a method, the plant-breeder has a fine, unexplored field before him in the leguminous and cruciferous fodder crops, and again in the fibre plants. Commercial flax, for example, is an entirely heterogeneous mixture of varieties, which never appears to have been subjected to the most ordinary selection. The fodder crops are matters of immediate importance; because the more intensive cultivation of the western side of Great Britain, where the high rainfall renders the growth of cereals a somewhat speculative industry, subject to loss at harvest and difficulties in the spring preparations for sowing, depends upon the elaboration of a system of farming based upon rapidly growing fodder crops. At present these districts produce milk, meat, and store stock, mainly from grass land that gets but little aid from the cultivator. The gross productive power of such land is small, and under the plough can be enormously raised, but arable farming has hitherto been avoided, except at times of abnormal prices, because of the risks attending harvesting. With improved fodder crops in place of grain a more profitable system of husbandry would replace the crops. Again, a new country like Australia will have to evolve its own fodder crops to suit the climate, and its own soil regenerating plants.

Despite the fact that a given area of land will produce something like ten times as much human food of a vegetable nature as of meat and milk, if mere power of supporting life is considered, we may assume that the human race will not for a long time, if ever, turn to vegetarianism. Absolute pressure of population, supposing the maximum has to be supported that the land can be made to carry, would put an end to the preliminary conversion of vegetable into animal food, but it is probable that the dominant races will insist on remaining flesh-eaters even if that necessitates the limitation of their own numbers. However, the scientific man has at present little to say to this sociological question; his business is to make the animal a more efficient converter of coarse vegetable fodder into high-grade food. That there is plenty of room for development in this direction may be inferred from the facts that Prof. Wood has directed attention to in the paper he has recently submitted to this section. What the grazier calls a good doer will lay on as fat and flesh 20 per cent. of the energy it receives in its food, as against 7 per cent. stored by a bad doer; here is an enormous margin for improvement if the average cattle are only brought up to the level of efficiency of the best. No one has yet worked out the most economic rate of feeding for different classes of live stock, the type of ration that will produce the largest amount of meat from a given weight of food, independent of the rate at which the increase takes place.

Granted the dependence upon research of the agriculture of the future if it is to meet the requirements of an increased population and a more advanced state of society, how can the required investigations best be organised? We may take it for granted that in some form or other the State must find the funds; in this connection at any rate there are no prizes for the private worker such as would make agricultural research a tempting, even a possible, commercial speculation. There is a very limited field for patents or royalties; the breeder of a new crop variety can only exploit it with success if he has some big commercial organisation behind him, and even then a very few seasons place it in everyone's hands. The solutions to most of the great outstanding problems which I have outlined above could not be sold at a price, however much they might improve the output of every farmer. Indeed, there is this character about the advances which science may make in agriculture, and it explains the lack of interest in research exhibited by many hard-headed farmers, that the benefit comes to the community rather than to the individual. Farmer is competing with farmer, and if production is raised all round the price is apt to drop correspondingly, so that shrewd men who are doing very well as things are, are very content with their limited vision, provided the general ignorance remains unenlightened. However, we need not argue this point; every civilised country has accepted the necessity of maintaining agricultural research; even Great Britain, the last home of go-as-you-please, has fallen into line within the last year or two.

Assuming that the State pays, shall the immediate organisation and control of the work remain with the State direct, or be placed in the hands of semi-official bodies like the universities? The character of the work required must settle this question. We may as well make up our minds at the outset that agricultural research is a very complex affair, which is going to arrive at commercial results very slowly. It deals with the fundamental problems of life itself; its problems mostly lie in the border country where two or more sciences meet, the debatable land which the man of pure science distrusts and affects to despise because there his clean and simple academic methods do not apply. Hence we have to attract to research in agricultural matters minds of the very best quality, men of imagination and determination, and give them scope and freedom to make the best of themselves. Now it has been recently claimed that the nation can only attract men of the necessary quality to research by instituting some system of prizes that shall be commensurate with the rewards that lie before the successful lawyer or business man, who has embarked upon some competitive commercial career. I entirely dissent from this view; the quality of a man's work is not to be measured by the results it happens to attain, for results are often matters of luck, but least of all is to be measured by the amount of public attention the results arouse. It is in the nature of some kind of discoveries to excite the popular imagination, but these discoveries do not necessarily involve more credit to the discoverer than many others the burial-place of which in this or that volume of Transactions is known only to a select few. Once make publicity the criterion, and the scientific man is at the mercy of the boom and the advertisement; a good newspaper manner is more valuable than high thinking. Moreover, I would for the man of science say with Malvolio: "I think nobler of the soul." Give him a living wage and proper opportunities and he will give his best work without the added inducement of a chance of making his fortune. The real point is the living wage, and this does not mean the starveling price at which a man can be bought just after taking his degree. At present the career of research has some of the aspects of a blind-alley employment, the young man enters on it with enthusiasm, only to find ten years later that he has no market value in any other occupation and that he is expected to continue on an artisan's wage.

We have then to ensure the scientific man continuous employment; in such special subjects as agricultural science presents, we cannot trust to pick him for a particular job, and let him go when it is finished; there must be some reasonable sort of a career in investigation. The State cannot simply pay for results; men will not qualify for such precarious chances of employment. The great results come as incalculably as the great poetry, their value is similarly untranslatable into the cash standard, and though no provision of posts can ensure a supply of the finest flowers of the mind, routine science has this advantage over routine poetry, that it has some value and is even necessary to bring to fruition the advances of the pioneers. And when the great mind does happen to be born, he can only be turned to account if an organisation exists within which he can find opportunities for work. Now such an organisation seems to be provided by the universities rather than by the State. The type of man who makes an investigator is apt to be markedly individual; he can work better under the looser system of control that prevails in a university than under the official hierarchy of a Government department. The methods of research are anarchical, and ought to be continuously destructive of accepted opinions; when a Government department takes an official point of view, it is apt to insist on its being respected, and not criticised by its officers on the strength. It has happened within recent years that a scientific man in Government employment has had to choose between his salary and his conscience, and though university laboratories are not always temples of free thought, their atmosphere is distinctly more open than that of a Government office. The type of man most fitted for research is more attracted by a university than a department; he wants his value to be measured by the quality of his scientific work, rather than by his official adaptability. But the greatest objection to making research a function of Government is that it is of necessity subjected to an annual detailed justification of its expenditure to a non-expert legislative body. When one reads the cross-examination of this or that investigator by the Committee of Public Accounts of certain States which maintain departments of agricultural research, one realises the hopelessness of expecting the slow, far-reaching scientific work that ultimately counts, from men who are subject to such an annual criticism. The almost complete sterility of certain State organisations for research on a great scale can be absolutely set down to the call that prevails for an annual report of results which seem to pay their way; only a talent for advertisement comes to the front under such a *régime*. Of course, a State must maintain laboratories which undertake a certain amount of investigation in connection with its duties in the control of disease, etc., but, though it may be difficult to draw a defining line between research that arises out of administration and research in pursuit of knowledge, the distinction is easy to make in practice. For example, the State needs a veterinary laboratory for the purpose of checking the conclusions upon which the administrative regulations regarding this or that disease are based, and of testing serums, vaccines, and the like, but it would prove false economy in the end to entrust to this official institution the sole responsibility for investigations into animal diseases.

Another advantage that arises from entrusting agricultural research to the universities is that thereby one obtains the advice, and often the active co-operation of men in the departments of pure science. I have already indicated how complex are the questions that agriculture raises; the man who is working out soil problems may find one day that he is brought to a standstill by some physical or even mathematical difficulty he is not competent to deal with, on another occasion he may wish to consult a geologist, or again a zoologist. No soil laboratory pure and simple can afford to have men of all these qualifications upon its strength, but if it is attached to a university, its men are naturally in constant contact with other specialists from whom they may informally obtain the assistance they need. A special purpose laboratory must suffer if it is isolated from the general current of science, and this is particularly true of agriculture with its many contacts, and the natural inclination to locate its institutions in the country. Some link must be maintained between the research institution and the practical farmer, not so much for the sake of the latter, because he is rarely in a position to utilise directly, or even to understand, the work of the investigation, but in order to keep the work real and non-academic. Even from the purely scientific point of view the most fruitful lines of research are those suggested by practical life; many effects that prove to be of fundamental importance to theory, only become apparent in the large-scale workings of the commercial undertaking. The contact with farming that the research-worker needs should be provided by his association with the university department that is teaching agriculture and advising the farmers of its district; thus is established the connection that on one hand brings the farmer's problems to the investigators, and on the other translates the investigators' results into practical advice. As I see it, the ideal organisation of research in agriculture is to associate a more or less specialised institution for the investigation of a particular class of problem with a university possessing an agricultural department, which is also charged with extension work by way of lectures and advice within its own sphere of influence. How specialised the institution may become must depend upon the numbers of universities available, but there is a real economy in specialisation, in inducing each institution to throw its whole strength into one line of work, for universities, like men, cannot afford to be Jacks of all trades.

Many of my hearers may think I am sketching out a very ambitious and extensive programme about which the only certainty is the creation of a considerable number of salaried posts for men of science, but when I think of the futilities upon which so much public money is spent in every country, I am almost ashamed to justify the expenditure by pointing out that an increase of 10 per cent. in any one of the staple crops of a country, such an increase as is well within the powers of the scientific man to effect in no great length of time, would pay over and over again for the organisation I have indicated. Even if the research went on for the sake of knowledge alone, every nation is able to allow itself a certain amount of intellectual luxury. Moreover, to return to my original text, it is only by the aid of agricultural science that the world is ultimately going to be allowed to enjoy any luxuries at all; as the fundamentally agricultural basis of society again becomes apparent, the one thing that will save it from sinking down into a collection of families each wringing a bare subsistence from a tiny plot of ground will be the application of the fullest knowledge to the utilisation of the land.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—In consequence of the abnormal conditions created by the war, the election to the Poynting chair of physics has been postponed, and Dr. G. A. Shakespear has been appointed acting professor of physics.

EDINBURGH.—Dr. G. L. Gulland has been appointed to the chair of medicine, vacant through the resignation of Prof. Wyllie.

LONDON.—It is announced that Sir Henry Miers, F.R.S., has resigned the principalship of the University in order to accept the appointment of Vice-Chancellor of Manchester University. The resignation has been accepted by the Senate with great regret. Sir Henry Miers was appointed principal in 1908, in succession to Sir Arthur Rücker, F.R.S. He was formerly Waynflete professor of mineralogy at Oxford.

OXFORD.—On January 26 Convocation gratefully accepted a sum of 450*l.* offered to the University by friends of the late Prof. Gotch, with the view of perpetuating the memory of the late Waynflete professor, and of encouraging the study of physiology within the University. The income of the fund will be applied, first, to the establishment of a Gotch memorial prize to be awarded annually, after examination, to a student in the physiological laboratory; and, secondly, to the creation and maintenance of a Gotch memorial library in the same laboratory. A portrait of Prof. Gotch is now hung on the walls of the department which was the scene of his fruitful labours.

In the same Convocation leave of absence was given to Prof. G. C. Bourne, Linacre professor of comparative anatomy, who is engaged in military service. Mr. E. S. Goodrich is acting meanwhile as the professor's deputy.

The books bequeathed to the University by the late Prof. Ingram Bywater, are stated by Sir William Osler, F.R.S., regius professor of medicine, to be of high value and interest.

THE Secretary of State for India has appointed Mr. L. G. Owen to be professor of mathematics at the Government College, Rangoon. He has also appointed Mr. W. Fyfe to the post of Instructor in Manual Training for the Madras Presidency.

AMONG the bequests included in the will of the late Dr. I. Burney Yeo, emeritus professor of medicine at King's College, London, are 3000*l.* to the Royal Medical Benevolent College, Epsom, and 5000*l.* to King's College (London) Hospital Medical School for a "Burney Yeo Fund" to be used for furthering the success of the school.

THE London County Council has arranged for a free course of lectures to be given at the Horniman

Museum, Forest Hill, S.E., at 3.30 p.m. on Saturday afternoons, commencing on January 30, upon the following subjects:—Lightning and the thunderbolt in folk-lore, Mr. E. Lovett; From the ancient herbalist to the modern botanist, Dr. E. Marion Delf; The history and associations of the art of spinning by hand, Mr. W. Dale; The history of writing, Mr. A. R. Wright; Children's toys: their origin and folk-lore, Mr. E. Lovett. Particulars of further lectures will be announced later.

AT the end of last month the Merchant Venturers' Technical College, Bristol, published a preliminary list of present and former members of the College who are at present serving with the Army or Navy, and who have volunteered for service; 362 names were included, but since the list was printed additional names have been received daily, and the total now amounts to 416. Among those whose names appear in the list, there are 26 naval officers and 36 officers holding commissions in the Army. Perhaps the best known name amongst the former students who appear in the list is that of Squadron Commander E. F. Briggs, who received his engineering training in the College, commanded the aerial raid on the Zeppelin factory at Friedrichshafen, and was wounded and captured there in November last.

WE have received a copy of the first issue of a new American educational periodical entitled *School and Society*. It is to be a weekly magazine, and will follow the general lines that are familiar to us in this country in our contemporary *Science*. The paper will be conducted by the editor of *Science*, Prof. J. McKeen Cattell, professor of psychology in Columbia University, and is intended chiefly for teachers in the lower and higher schools of the United States. Among the contributors to the first issue are Dr. Eliot, president emeritus of Harvard University, and Prof. G. Stanley Hall. We commend the new publication to students of education as likely to provide authoritative information about educational effort in the United States in an interesting and attractive form. The magazine is published by the Science Press of New York City, and each number costs 10 cents.

A BEQUEST of 600,000*l*. to Oberlin College by Dr. C. M. Hall, the distinguished electrochemist and manufacturer of aluminium, is announced in the issue of *Science* for January 15. The bequest is in the form of 400,000*l*. endowment to be used for any purpose, 100,000*l*. to be used to build an auditorium, 20,000*l*. for the auditorium's maintenance, and 40,000*l*. to be spent for improvements to the grounds. The college receives in addition all property in Oberlin owned by Dr. Hall, and a valuable art collection. From the same source we learn that by the will of Miss Grace H. Dodge, for many years known for her educational and philanthropic activities in New York City, contains bequests of 280,000*l*. for educational and charitable purposes, as well as a number of deferred bequests of the same character. The sum of 100,000*l*. is bequeathed to Teachers College, Columbia University, in the founding and conduct of which she took an active part. The college will receive two deferred bequests, one of which may be large.

THE fifth report of the Royal Commission on the Civil Service (Cd. 7748) is concerned with the Diplomatic Service (including the Foreign Office) and the Consular Service. Among the recommendations of the Commissioners made in connection with the Diplomatic Corps and the Foreign Office, are the following:—The existing property qualification for admission to the Diplomatic Corps (*i.e.* the possession of a private income of at least 400*l*. a year) should be abolished. The Board of Selection, which interviews applicants for the diplomatic establishment of the Foreign Office and for the Diplomatic Corps, and upon the reports of which nominations to sit at the examination are granted by the Secretary of State, should be reconstructed on a broader basis, and should include a non-official member. The existing requirement that applicants for the diplomatic establishment of the Foreign Office and for the Diplomatic Corps should first obtain the permission of the Secretary of State to appear before the Board of Selection should be removed. All applications should be laid directly before the Board of Selection. The entrance examination for the Foreign Service (*i.e.* the diplomatic establishment of the Foreign Office and the Diplomatic Corps) should be the combined examination for the administrative grades of the General Civil Service (Class I.) A small Departmental Committee should be appointed with a view of providing for the better training of junior members of the Diplomatic Corps, the reduction of its numbers, the devolution of routine work, and the improvement of office methods abroad. In connection with the Consular Service, it is recommended that recruitment should be by open competition in all branches of the Consular Service. The principle should be adopted of taking young men at an age corresponding to a definite stage in the educational system of the country, and then training them for their work. On passing out of training, probationers should be appointed to the grade of Consular Assistant, and placed under the charge of a selected Consul at an important station to learn practical work.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 21.—Sir William Crookes, president, in the chair.—Dr. C. **Chree**: Atmospheric electricity potential gradient at Kew Observatory, 1898–1912. A previous paper discussed results obtained from the Kelvin water-dropping electrograph at Kew Observatory for the period 1898–1904. The present paper discusses the data from the fifteen years 1898–1912. Particular attention is given to the character of the diurnal variation, as to how it varies throughout the year, and as to the nature of the differences apparent between different years. The predominance of the 12-hour term over the 24-hour term in the diurnal variation, which is especially conspicuous in summer, is found to vary greatly from year to year. The 12-hour term shows less fluctuations either in amplitude or phase than the 24-hour term.—Prof. A. E. H. **Love**: The transmission of electric waves over the surface of the earth.—An analytical solution of the general equations of electrodynamics is obtained for the case of waves generated by a vibrating doublet in presence of a conducting sphere, and is adapted to obtain the known solution for perfect conduction, and the correction for moderate resistance, such as that of sea-water. The known solution is expressed by the sum of a series involving zonal harmonics, and the correction by a similar series. Different results have been obtained by different writers who have investigated the numerical value of the former sum. In the paper a new method of summing the series is explained, and worked out in detail for the wave-length 5 km. In the case of perfect conduction the result confirms that found by H. M. Macdonald (Proc. Roy. Soc., Ser. A, vol xc., 1914, p. 50). The effect of resistance is found to be a slight increase of the strength of the signals at considerable distances, counteracting to some small extent the enfeebling effect of the curvature of the surface.—L. **Silberstein**: Electromagnetic waves in a perfectly conducting tube. The problem of waves in conducting tubes, which has already been treated by various authors, is here taken up with the purpose of developing some of its solutions which offer noteworthy peculiarities with respect to the velocity of the corresponding waves. The waves investigated are axially symmetrical and of permanent type. Their velocity of transfer along the tube is a comparatively simple function of the period of vibration and of the "order" of waves, and it exceeds, for each of these waves, the velocity of light in free space. The peculiarities of distribution of the lines of force are illustrated by two examples with annexed drawings. The paper closes with remarks concerning superpositions of waves of the specified kind, more especially of electromagnetic pulses.—H. B. **Keene**: An electrically-heated full radiator. The essential conditions in a determination of the constant of the Stefan-Boltzmann law of radiation are, either that both "emitter" and "receiver" are full radiators, or that the amount by which they fall short of full radiators is known—an amount difficult to determine with certainty. Hitherto, a measurement of this constant has not been made under full radiation conditions. This paper describes an electrically-heated "constant temperature enclosure" which has been constructed for temperatures in the neighbourhood of 1100° C. It consists of a hollow cylinder of alumina, about 8 in. in diameter, closed with conical end pieces of the same material. Three separate windings of platinum strip provide a means of adjusting the temperature distribution within the enclosure, which can be made uniform to within two or three degrees. At the apex of one of the cones is a circular aperture which emits radiation closely approximating to full radiation. It is intended to use this radiator in conjunction with a full receiver, described in an earlier paper, in order to determine the value of the radiation constant under "black-body" conditions.

Geological Society, January 6.—Dr. A. Smith Woodward, president, in the chair.—C. I. **Gardiner**: The Silurian inlier of Usk (Monmouthshire). The Usk inlier lies a few miles north of Newport (Mon.). Between the coalfields of South Wales and the Forest of Dean the Old Red Sandstone is bent into an anticline, the axis of which runs very nearly north and south. This has been denuded away to the west of Usk, and Silurian beds have been exposed, the rocks seen being of Ludlow and Wenlock age. In the southern part of the inlier the Silurian rocks are arranged in two anticlinal folds, the axes of which run nearly north and south and dip southwards. These folds are separated by a fault. The Old Red Sandstone is believed to rest unconformably on the Ludlow Beds along much of the margin of the Coed-y-paen anticline, and beneath the Ludlow beds, which are about 1300 ft. thick, come 35 to 40 ft. of a Wenlock Limestone, which covers Wenlock Shales: of these latter some 850 ft. are seen. At their base the Ludlow Beds seem to pass conformably down into the Wenlock Beds, and the Wenlock Limestone is probably not at the summit of the Wenlock Shales. The Wenlock Limestone occurs either in irregular layers separated by sandy shales, or in massive beds largely made up of crinoid fragments.—S. R. **Haselhurst**: some observations on cone-in-cone structure and their relation to its origin. In a brief review our state of knowledge is summarised, and the deductions of other investigators are analysed. The author critically examines the accepted hypothesis that cone-in-cone structure is something essentially due to crystallisation. He describes the results of some high-pressure mimetic experiments. These experiments were designed to produce this structure, and reveal what the author believes to be many new points on the origin of concretions and cone-in-cone in particular. The experiments are new, inasmuch as the media used, namely: brittle, semi-plastic, and plastic, are enclosed in tunics of varied design, and then subjected either to a high uniform hydrostatic pressure or to a direct thrust. The author concludes from the evidence:—(1) That cone-in-cone is not due to crystallisation, but is a mechanically produced structure due to great and localised pressure; (2) that it is closely allied to the phenomenon known as pressure solution; (3) that cone-in-cone structure is closely associated with other rock-structures which are mutually indicative the one of the other, and also of their mode of origin.

EDINBURGH.

Royal Society, December 21, 1914.—Sir Thomas Fraser, vice-president, in the chair.—Sir Thomas **Fraser**: The poisoned arrows of the Abors and Mishmis of north-east India, and the composition and action of their poisons. A large collection of arrows, bows, and quivers had been received from time to time from medical and military officers of the Indian Army, and it was soon apparent that different poisons were used in different groups. In one group, chiefly used by the Mishmis, the action of the poison suggested aconite as the active agent. In another group, used by the Abors, the arrows yielded, on extraction with ether, an oil with the physical characters of the oil of *Croton tiglium*. This oil could not produce death in warm-blooded animals, but was lethal to frogs. The poison on the aconite arrows varied greatly in power. If the whole of the poison of one arrow were absorbed, a most improbable possibility, the most active arrows carried enough to kill three men. —J. Herbert **Paul**: Regeneration of the legs of Decapods from the preformed breaking planes. When a lobster, hermit crab, or shore crab loses a limb, a small limb bud forms as the first stage in the process of regeneration. When the animal moults, this bud rapidly expands to the size of the true complete limb, becomes covered with a hard calcified layer like the rest of the integument, and gains full functional power in a few days. The paper contained a detailed account of the manner in which the various stages of regeneration were effected. When the old limb is lost the valvular action of the diaphragm at the breaking plane prevents hæmorrhage; and in the regenerative process a new diaphragm is the first structure laid down.—Prof. Alex. **Smith** and R. H. **Lombard**: The degrees of dissociation in the saturated vapours of the ammonium haloids. The paper was concerned with the densities and degrees of dissociation of the chloride, bromide, and iodide of ammonium. In the chloride the degree of dissociation was nearly constant within the range of temperatures from 280° to 330°; in the bromide it reached a maximum about 320°, and diminished steadily up to 388°; and in the iodide it was practically zero. There was evidence in the last case of association above 340°. The results for the bromide showed that, about 320°, the heat of dissociation was positive. This seemed to be the first observation of a positive heat of dissociation in the gaseous state.

PARIS.

Academy of Sciences, January 11.—M. Ed. Perrier in the chair.—L. **Lecornu**: The deformation of cylindrical tubes.—André **Blondel**: Calculation of the range of optical projectors both on land and sea. A formula is deduced in which certain constants can only be determined experimentally, and suggestions are made as to the best means of determining these constants. — Edouard **Heckel**: *Solanum Caldasii*

Kunth (*S. guaraniticum,* Hassler) from the systematic point of view. *S. Caldasii* and *S. etuberosum* have been regarded by Berthault as identical species. The author points out their differences, and states that the only point they have in common is the fact that they both occur in Chili.—F. **Bompiani**: The geometry of Laplace's equation.—J. **Cabannes**: The diffusion of light by air. A beam of light from a quartz mercury lamp was examined at right angles to the path of the beam, and measurements made both optically and photographically of the intensity of the diffused light. No diffusion occurs when the beam is in a vacuum, and Lord Rayleigh's diffusion formula was quantitatively confirmed.—L. **Gay**: The expansibility product.—Œchsner de **Coninck**: The molecular weight of the oxybenzoic acids. The method is based on the determination of the calcium in the calcium oxybenzoates, these being obtainable in a state of high purity.—J. **Repelin**: The prolongation towards the east of the Senonian synclinal of the Plan d'Aups, Saint-Baume.—Jean **Chautaud**: The origin of the petroliferous mounds of Texas and Louisiana. Contribution to the study of the origin of petroleum. The hypotheses put forward to account for the formation of these mounds are not in accord with the geological structure of the region. These hypotheses are criticised in detail, and it is shown that the mounds have an origin which is independent of orogenic or eruptive actions. The processes of formation suggested by the author are sedimentation in an intermittent lagoon, followed by a hydrocarbon decomposition of the organic *débris,* the transformation of the anhydrite into gypsum, with resulting compression and the migration of the petroleum under the influence of the pressure exerted on the mother rocks.—N. **Arabu**: Studies on the Tertiary formations of the basin of the Sea of Marmora. The Vindobonian in Thrace.—A. **Boutaric**: The polarisation and absorptive power of the atmosphere. Observations carried on during three years confirm the views of K. Angström that the absorptive power of the atmosphere should depend on the diffusion and quantity of the absorptive gas present, mainly water vapour. The main factor is shown to be the diffusion. From observations of calorific intensity, polarisation, and hygrometric state carried out at a given station for some years, it is possible to predict the calorific intensity at different times on a given day from measurements of the polarisation and hygrometric state, or even from a simple polarimetric observation alone.—A. **Goris** and Ch. **Vischniac**: Tormentol, a principle extracted from *Potentilla tormentilla.* The substance is crystalline, contains no nitrogen, and has the composition $C_{33}H_{50}O_{10}$. Its constitution has not been completely worked out, but it is an ether-alcohol.—F. **Bordas**: A new arrangement for the disinfection of clothing. A description of an apparatus, easily put together, capable of disinfecting with steam at a temperature of 105° to 108° the clothes of five hundred men per hour.—Victor **Henri**: The possibility of phosphorus being carried into wounds produced by the projectiles of the German artillery (see p. 598).—W. R. **Thompson**: An intracuticular parasite of *Hamemalis virginiana.*

January 18.—M. Ed. Perrier in the chair.—Maurice **Hamy**: The exact determination of the collimation of non-reversible meridian telescopes. It is shown that the usual method of adjustment with two collimators may be affected by a systematic error and the substitution of two plane parallel mirrors is suggested, their diameter being at least equal to that of the objective of the instrument. Such mirrors can now be made with high precision, and a method of adjusting them to exact parallelism is given.—M. **Guichard**: Surfaces such that the centres of the spheres osculating the lines of curvature of a series, shall be a paraboloid of revolution.—F. **Gonessiat**: Results of the observations of two occultations of the Pleiades by the Moon. Details of observations made at Algiers on September 20 and December 11, 1914.—B. **Jekhowsky**: Observations of Delevan's comet, 1913*f*, made at the Observatory of Paris, with the equatorial in the western tower of 30·5 cm. aperture. Positions are given for December 18, 24, 26, 28, and 29, both of the comet and the comparison stars. On December 29 the comet appeared as a rounded nebulosity 40 seconds diameter with a nearly stellar nucleus of 6·5 magnitude.—G. A. **Miller**: Sylow's theorem.—Foveau de **Courmelles**: Determination of the position of projectiles in the human body by radioscopy. Two methods based on the use of a fluorescent screen are described.—J. **Bougault** and Mlle. R. **Hemmerlé**: The tautomerism of phenylpyruvic acid. In a previous communication J. Bougault suggested that phenylpyruvic acid might exist in two tautomeric forms, enolic and ketonic. Further proofs of this isomerism are now given, based on the differences in reactivity of the acid and its alkali salts towards acetic acid, potassium permanganate, and semicarbazide. The free acid has the enolic form, $C_6H_5.CH : C(OH).CO_2H_1$, the neutral salts being ketonic, $C_6H_5.CH_2.CO.CO_2M$. The conditions for passing from the one form to the other have been studied.—Ch. J. **Gravier**: A phenomenon of multiplication by longitudinal scission in a Madrepore, *Schizocyathus fissilis.*—Alfred **Angot**: Value of the magnetic elements at the Val-Joyeux Observatory to January 1, 1915.—Alfred **Angot**: The earthquake of January 13, 1915. From the records of the seismograph at Parc Saint-Maur; the position of the epicentre was easily fixed at about 1300 kilometres S.E., that is, in Italy. The displacement was much less than that caused by the earthquake in Russian Turkestan on January 3, 1911.—J. **Danysz**: The treatment of wounds by solutions of nitrate of silver of strengths 1 in 200,000 to 1 in 500,000. A demonstration of the advantages of using certain antiseptic substances, especially silver nitrate, in very dilute solution.

BOOKS RECEIVED.

Smithsonian Miscellaneous Collections. Vol. lxii., No. 6. Smithsonian Physical Tables. Prepared by F. E. Fowle. Sixth revised edition. Pp. xxxvi+355. (Washington: Smithsonian Institution.)

Egyptian Government. Almanac for the Year 1915. Pp. viii+250. (Cairo: Government Press.) P.T.5.

The South African Institute for Medical Research. Anthropological Notes on Bantu Natives from Portuguese East Africa. By G. D. Maynard and G. A. Turner. Pp. 35. (Johannesburg: South African Institute for Medical Research.) 2*s.* 6*d.*

The Case-Hardening of Steel. By H. Brearley. Pp. xv+169. (London: Iliffe and Sons, Ltd.) 7*s.* 6*d.*

African Adventure Stories. By J. A. Loring. Pp. x+301. (London: G. Allen and Unwin, Ltd.) 6*s.* net.

The History of Melanesian Society. By W. H. R. Rivers. Vol. i. Pp. xii+400. Vol. ii. Pp. 610. (Cambridge University Press.) 2 vols. 36*s.* net.

Macmillan's Geographical Exercise Books. iii. The British Isles, with Questions by B. C. Wallis. Pp. 48. (London: Macmillan and Co., Ltd.) 6*d.*

A Shilling Arithmetic. By W. M. Baker and A. A. Bourne. Pp. xiv+192. (London: G. Bell and Sons, Ltd.) 1*s.*

Papers set in the Qualifying Examination for the Mechanical Sciences Tripos, 1906–1913. Pp. 90. (Cambridge University Press.) 2*s.* net.

Advanced Inorganic Chemistry. By P. W. Oscroft. Pp. viii+504. (London: G. Bell and Sons, Ltd.) 5*s.* net.

Economic Cycles: Their Law and Cause. By Prof. H. L. Moore. Pp. viii+149. (London: Macmillan and Co., Ltd.) 8*s.* 6*d.* net.

Homogeneous Linear Substitutions. by Dr. H. Hilton. Pp. viii+184. (Oxford: Clarendon Press.) 12*s.* 6*d.* net.

Materials of Machines. By A. W. Smith. Second edition. Pp. v+215. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5*s.* 6*d.* net.

Machine Shop Practice. By W. J. Kaup. Second edition. Pp. xii+199. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5*s.* 6*d.* net.

Mechanism of Steam Engines. By W. H. James and M. W. Dole. Pp. viii+170. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s.* 6*d.* net.

Quain's Elements of Anatomy. Eleventh edition. Vol. iv. Part 1. Osteology and Arthrology. By Dr. T. H. Bruce. Pp. viii+329. (London: Longmans and Co.) 12*s.* 6*d.* net.

Inorganic Plant Poisons and Stimulants. By Dr. W. E. Brenchley. Pp. ix+110. (Cambridge University Press.) 5*s.* net.

Tables Annuelles de Constantes et Données Numeriques, de Chimie, de Physique, et de Technologie. Vol. iii. Année 1912. Pp. lii+595. (Paris: Gauthier Villars et Cie.; London: J. and A. Churchill.) 28*s.* 6*d.* net.

The Determination of Sex. By Dr. L. Doncaster. Pp. xii+172. (Cambridge University Press.) 7*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY, January 28.

Royal Society, at 4.30.—The Influence of Salt-concentration on Hæmolysis: W. W. C. Topley.—The Life-cycle of Cladocera, with Remarks on the Physiology of Growth and Reproduction in Crustacea: G. Smith.—Investigations on Protozoa in Relation to the Factor Limiting Bacterial Activity in Soil: T. Goodey.—The Mesodermic Origin and the Fate of the so-called Mesectoderm in Petromyzon: S. Hatta.—The Influence of Homodromous and Heterodromous Electric Currents on Transmission of Excitation in Plant and Animal: Prof. J. C. Bose.

Royal Institution, at 3.—Modern Theories and Methods in Medicine—Immunity: H. G. Plimmer.

Institution of Electrical Engineers at 8.—The Sixth Kelvin Lecture Lord Kelvin's Work on Gyrostatics: Prof. A. Gray.

FRIDAY, January 29.

Royal Institution, at 9.—Gaseous Explosions: Dr. Dugald Clerk.

SATURDAY, January 30.

Royal Institution, at 3.—Aerial Navigation—Scientific Principles: Dr. R. T. Glazebrook.

Essex Field Club (at the Essex Museum of Natural History, Stratford), at 6.—Paget Colour Photography as applied to Natural History: H. Whitehead.—The Hammer and the Camera: W. Whitaker.

MONDAY, February 1.

Society of Chemical Industry, at 8.

Aristotelian Society, at 8.—Conflicting Obligations in the State: G. H. D. Cole.

Royal Society of Arts, at 8.—Oils, their Production and Manufacture: Dr. F. Mollwo Perkin.

Victoria Institute, at 4.30.—Present Position of the Theory of Organic Evolution: Prof. E. W. MacBride.

Society of Engineers, at 7.30.—Presidential Address: N. Scorgie.

TUESDAY, February 2.

Royal Institution, at 3.—Muscle in the Service of Nerve: Prof. C. S. Sherrington.

Royal Society of Arts, at 4.30.—Sugar and the War: E. R. Davson.

WEDNESDAY, February 3.

Society of Public Analysts, at 8.—Annual General Meeting.—President's Address.—Note on the Determination of Sulphates in Flour: G. D. Elsdon.—General Principles Governing the Complete Analysis of Minerals and Ores: Dr. W. R. Schoeller.

Royal Society of Arts, at 8.—Imperial Industrial Development after the War: O. C. Beale.

Institution of Electrical Engineers, at 7.30.—Student's Meeting. High Explosives: H. Williams.

Entomological Society, at 8.

Geological Society, at 8.—The Gravels of East Anglia: T. McKenny Hughes.—The Pitchstones of Mull and their Genesis: E. M. Anderson and E. G. Radley.

THURSDAY, February 4.

Royal Society, at 4.30.—*Probable Papers:* Discontinuous Fluid Motion Past a Bent Plane, with Special Reference to Aeroplane Problems: Prof. G. H. Bryan and R. Jones. The Spectra of Ordinary Lead and Lead of Radio-active Origin: T. R. Merton.—The Viscosity of the Vapour of Iodine: A. O. Rankine.

Royal Institution, at 3.—Modern Theories and Methods in Medicine Methods and Results: H. G. Plimmer.

FRIDAY, February 5.

Royal Institution, at 9.—Science and Industrial Problems: Prof. A. W. Crossley.

Geologists' Association, at 7.30.—Annual General Meeting.

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THURSDAY, FEBRUARY 4, 1915.

THE WEB OF LIFE.

Tierbau und Tierleben in ihrem Zusammenhang betrachtet. By Prof. Dr. F. Hesse and Prof. Dr. F. Doflein. Band ii. Das Tier als Glied des Naturganzen. By Franz Doflein. Pp. xv+960+plates. (Leipzig and Berlin: B. G. Teubner, 1914.) Price 20 marks.

ONE of the fundamental ideas of biology, which found many illustrations in the work of Darwin, is that of the inter-relatedness of organisms in the web of life. Just as there is a correlation of organs in the body, so there is a correlation of organisms in the economy of nature. No creature lives or dies to itself; the orbit of one life influences many others; everywhere we find linkages and wheels within wheels. An organism is compared by Prof. Doflein to a modern house, connected by various pipes and wires with other houses in the city and with the outer world, but the image is crude and too static. It is only in man's personal affairs that we find anything like the manifold, intricate, and subtle inter-relations that are to be seen in vigorous animals leading a full life. It is, indeed, altogether a matter of action and reaction between organism and environment, but with what complexity and nuance! Now things are in the saddle coercing the organism, and again the living creature exercises its prerogative and becomes master of its fate.

Prof. Doflein, Weismann's successor at Freiburg, has been studying this aspect of animal biology for more than ten years, and has given us his results in a work which must be placed in the front rank among ecological or bionomic studies. The book is nothing short of a great achievement. It has gathered interesting material from many fields; it includes much that is personal; it has worked out a clear classification of the manifold inter-relations; it is written in a vivid style; and if we said all we think about the abundance, freshness, and beauty of the illustrations, we should not be believed. We do not know of any British, American, or French book of natural history that even approaches it—a fact doubtless implying a smaller purchasing public. Prof. Doflein is well known for his work on the Protozoa and as a naturalist-traveller, and it is remarkable that he should have found time during the last ten years to write this large volume, a fit companion to its predecessor, by Prof. Hesse of Bonn, which treated of the organism as an individual.

In dealing with the comprehensive subject of the inter-relations of animals in the web of life, Prof. Doflein has evidently had in his mind throughout two allied, but distinct, general conceptions. The first is that of the organism as a bundle of adaptations to normal circumstances—what he calls "organisatorische Anpassungen"; the second is that of the organism as a self-assertive plastic agent, which can adjust itself to environmental vicissitudes—what he calls "regulatorische Anpassungen." The first is the hereditary racial equipment of wrought-out adaptations (as far as these concern give-and-take with animate and inanimate surroundings); the second is the individual capacity for adjustment, for modification, for thrusting as well as parrying. In both cases the adaptiveness may be structural, or functional, or psychical. Thus a ptarmigan from the mountains has a stronger heart than a willow-grouse from the plains—a structural adaptation. A bird or mammal continuously and normally regulates its production of heat according to its loss—a functional adaptation. Ants have an instinctive behaviour in relation to their queens—a psychical adaptation. But when a mammal transported to a cold country puts on a thicker coat, or when a bird adjusts the nature of its food-canal to altered diet, or when ants taken from Algiers to Switzerland entirely alter the door of the nest (in relation to new enemies), we have to deal with structural, functional, and psychical adjustments which are not more than individual reactions. This distinction between racial adaptation and individual adjustment is prominent in the book, but the author does not use it stiffly. He is clear, for instance, that the individual trades with his talents.

Beginning with the animate environment, Prof. Doflein deals with nutritive relations (including symbiosis, commensalism, parasitism, etc.); relations to enemies (including protective resemblance, mimicry, autotomy, etc.); sex-relations; migrations; care of offspring; social relations (including gregariousness, co-operation, and the communities of ants, bees, and termites). After 750 pages on these attractive themes, he passes to the inanimate environment, and deals with cosmic periodicities, the medium, the substratum, pressures, chemical influences, the quantity and quality of the food, temperature, climate, and light. This part of the book is like Semper's well-known work, "The Natural Conditions of Existence as they affect Animal Life" (1881), brought up to date. The volume ends with a discussion of the theoretical significance of adaptive structures and habits. What is new is the synthetic treatment of the whole question of inter-relatedness, which is, of course, fundamental in any biology worthy of the name, and the wealth of fresh material that the author has collected from far and near. Among the interesting plates, we may refer to those illustrating symbiosis, protective coloration, wild geese, the courtship of capercaillie and blackcock, cave animals, and phosphorescence.

As we pass from this valuable treasury of bionomics, many reflections rise. We recognise the impossibility of understanding details of structure apart from details of environment—a commonplace, of course, but illumined by some of the subtle instances that Doflein gives. We appreciate the light that the manifold inter-relatedness of organisms throws on the value of even small variations. The selective process has to be envisaged in relation to the web of life. We realise afresh the importance of the organism's active agency. It is modified by its environment and it is adapted to its environment; but there is more, it actually adapts the environment to itself. And, finally, we are filled once more with wonderment at the vision of life slowly creeping upwards through unthinkable ages, asserting itself insurgently amid a callous physical nature. All that the author of this fine work has told us confirms the impression of a deep tendency to inter-linking and systematisation—the Darwinian *systema naturae*—which is more than a mere image of what obtains increasingly, in spite of all rendings of the web, in the progress of mankind.

J. Arthur Thomson.

ASSAYING AT THE ROYAL SCHOOL OF MINES.

Assaying in Theory and Practice. By E. A. Wraight. Pp. xi+323. (London: Edward Arnold, 1914.) Price 10*s.* 6*d.* net.

THIS book will be welcomed by all assayers who appreciate the value of the teaching at the Royal School of Mines, and is of special interest to old students of the School, for the reason that it gives an account of the methods of assaying which have been taught there during the last few years. Almost all the notes issued to the students in the laboratory are contained in the book, and, in addition, besides other matter, the author gives some general remarks which will be of use to mine assayers and prospectors. Mr. Wraight is well equipped for the task of reminding his former students of what he has taught them. He was for some years the senior demonstrator in the assay laboratory of the Royal School of Mines, and in that capacity has been able to command the attention and affectionate respect of all who have come under his guidance. His work has only recently passed into other hands.

Mr. Wraight has made no attempt to write a complete book on assaying. The number of methods given is comparatively small and the gaps are considerable. For example, no mention is made of the volumetric methods of assay of silver bullion, or of the dry method for antimony, or of any method at all for platinum. The author observes that he has some thoughts of preparing a second volume containing analyses of ores, slags, etc., and of iron and steel. It may be hoped that he will include in it much besides these important sections.

As might be expected by those who know the author's work, there are few mistakes to be found in the book, and none of much importance. The method of determining silver in gold bullion given on p. 153 is an untrustworthy one, which is becoming obsolete. The method of parting with cadmium is not given. On p. 182 it is stated that graphite is not attacked by basic oxides. On p. 297, in the estimation of protective alkali in cyanide solutions, a decinormal solution of nitric acid is recommended instead of the usual oxalic acid or the fairly satisfactory sulphuric acid. The book certainly deserves a place on the shelf of works assayers. As a concise and clear statement of well-tried methods, it could scarcely be improved.

T. K. R.

JAPANESE MATHEMATICS.

A History of Japanese Mathematics. By D. E. Smith and Yoshio Mikami. Pp. vii+288. (Chicago and London: The Open Court Publishing Co., 1914.) Price 12*s.* net.

NOW that Europeans are becoming acquainted with the history of mathematics in Japan, it is possible for them to form a kind of general opinion about the work of Japanese mathematicians. Unless future research bring to light works of a calibre superior to those now known, we must acquiesce in the conclusions stated in the terminal pages of the present work. Briefly, they are that Japan has not originated any great and far-reaching theory, such as the infinitesimal calculus, or function-theory, or group-theory; while on the other hand, native methods of great ingenuity, applied to particular problems, did lead to equivalents for such things as Horner's method in solving equations, the general rule for computing a determinant, and a large number of ways of calculating π, some including the use of infinite series.

Another thing in which the older Japanese mathematicians excel is in dealing with a set of simultaneous equations; they are not baffled by the occurrence of huge coefficients in the course of elimination, and contrive to solve equations of incredibly high degrees. Finally, the elegant designs of familiar things, such as toys, fans, etc., suggested equally elegant problems of a quite distinctive kind, such as the Gion Temple problem, an account of which is given, pp. 197–8. The first solution involved an equation of degree 1024, which was successively reduced (we are told) to 46 and 10—the last by Ajima, who seems, so far as we can judge, to have been the greatest mathematician of his nation up to the present time.

The fourteen chapters of this book are all interesting, but we can only point out a few of the topics. There is an excellent account of the way of using sticks and abaci for calculation, and of the early system of notation; this is followed by showing how the same implements were used to solve equations, after the manner of Horner. Coming now to the third period (1600–1675 or so) we have circle-rectification of an Archimedean type, magic squares and circles, and something like a theory of quadrature. Seki Kōwa is the leading figure of the time, and chapter vi. is entirely devoted to him, and gives abundant evidence of his talent and ingenuity. The authors, however, class him rather with C. Wolf or Barrow than with Newton or Leibnitz. Chapter vii. deals with Seki's contemporaries and the probable importation of some western mathematics through contact with the Dutch.

Chapter viii. is on the *yenri,* or "circle principle." Practically, this means the formulæ connected mainly with cyclometry, some of which are essentially infinite series such as we have in analytical trigonometry (*cf.* for instance, pp. 152–3). Matsunaga worked out π to 50 figures in the eighteenth century.

Of the remaining chapters the most notable is that on Ajima Chokuyen (1739–1798). Among his achievements may be mentioned his (analytical) solution of Malfatti's problem, and his anticipation of Steiner by discovering poristic rings of circles touching each other and two given fixed circles. He also dealt with repeating decimals, diophantine problems, and quadrature; in the last he comes nearer than any of his predecessors to the idea of a definite integral as the limit of a sum. He may possibly have been influenced by European work.

A special feature of the book is the large number of illustrations. Those which are diagrams for problems are always elegant and often remarkably beautiful (*e.g.* pp. 96, 185, 186, 198, 240, 245); others are very instructive, like those of the abaci, pp. 30–31.

We cannot help asking ourselves: What is likely to be the trend of Japanese mathematics for the next generation or so? Japanese students are now made acquainted with the vast structure of European mathematics, and it is too massive and too much based upon the fundamental nature of things for them to ignore. If they are to add to it, they must become acquainted with it, unless they go on making pretty little things that the master-builders will put into their proper place. But it would be a great pity if, in striving to contribute to the substantial parts of the building, the Japanese were to bury their special talents, innate sense of asymmetrical beauty, and exceptional endurance and power of taking pains. Such things as on one hand celestial mechanics, and on the other diophantine analysis, seem admirably suited to their genius; if there be a planet of the solar system beyond Neptune, or if there be a proof of Fermat's last theorem, a Japanese is as likely to discover it as anyone.

G. B. M.

PRACTICAL EDUCATION.

(1) *A Handbook of Vocational Education.* By Dr. J. S. Taylor. Pp. xvi + 225. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 4*s.* 6*d.* net.

(2) *A Class-Book of Commercial Knowledge.* By E. J. Balley. Pp. iii + 125. (London: G. Bell and Sons, Ltd., 1914.) Price 1*s.* 6*d.*

(1) THE aim of Dr. Taylor's book is to give "a systematic survey of the general field of vocational education, embodying both the historical and logical aspects of the subject." But the author has not done full justice either to the subject or to himself by the short summary he has produced. With the introduction, pleading for equal opportunities for all, for education for citizenship, for a due recognition of the bearing of the industrial revolution on the teaching of trades, English opinion will be in full sympathy. So, too, with later chapters insisting on the need for guidance in the choice of an occupation, and on the part that trade schools should play in making good the loss of the thorough, all-round training afforded by the old apprenticeship system at its best. But the historical account of industrial education in Europe, given in chapter ii., is far too sketchy to be of real value.

Germany, and in Germany the admirable continuation school system of Munich, designed and built up by Dr. Kerschensteiner, holds pride of place, and the constructive side of Dr. Taylor's book may be said to be based on Dr. Kerschensteiner's principles. In his whole-hearted devotion to this master, who has exhibited in rare combination the talents of administrator as well as teacher, he forgets how much of Dr. Kerschensteiner's success is due to conscription. It is a conscript army that has rendered possible conscript continuation schools, and the iron discipline of the whole system of higher education in Germany. The essential condition of reform in continuation school work in Great Britain and in the United States is to secure there, as has been done in most German States, that young persons who have left the elementary school and gone to work shall continue their education in day, not night, classes. But the hope will be nursed on both sides of the Atlantic that this end will be achieved by some milder political measure than conscription.

As regards the training of vocational teachers, few will refuse assent to Dr. Taylor's contention that "a teacher of trades must be expert in two arts—the art of teaching and the art of some craft." Theorising on the subject, educationists tend to give excessive prominence to its pedagogic aspect. In practice they are forced to act like business-men, and to accept a working compromise.

The bibliography is quite inadequate. Perhaps the most notable omission is that of Dr. Stanley Hall's great work on "Adolescence." Even an American book should acknowledge the world's debt to that distinguished American philosopher.

(2) Few words are needed to commend Mr. Balley's "Class-book of Commercial Knowledge." It is an excellent little book, and should be of the utmost value in secondary schools where some introduction to commercial studies is at last being recognised as desirable. The form of the book is good, for it is planned like an up-to-date textbook on other secondary-school subjects, the examples are modern and business-like, the specimens of business documents bound up with the text are a pleasure to handle, and may even stir the imagination of a future captain of industry. The author has succeeded in his object, viz., to show that the subject of commerce is both educative and interesting. Bookkeeping proper has been wisely left alone, as a separate subject. In a new edition more might well be said in section iii., dealing with office work, on modern methods of card-indexing and filing.

OUR BOOKSHELF.

Świat I Czlowiek. By A. Heflich and S. Michalski. Vol. iv. Pp. 355. Second Edition. (Warsaw: Published by the Editors, 1913.) Price 2 roubles.

UNIQUE in its kind and of broad educational value is a Polish publication organised in Warsaw some years ago and edited from the beginning by Messrs. Al. Heflich and St. Michalski. The whole work, the aim of which is to help the self-educator in all the principal branches of scientific knowledge and scientific method, consists of three series: (i) "A Guide for Autodidacts," (ii) "Man and the Universe" (the universe in the light of the theory of evolution), and (iii) "The History of Thought." The recently-published second edition of vol. iv. of the second series contains a very interesting exposition of social evolution among animals and men, and of moral evolution, by Dr. L. Krzywicki, a thorough chapter on evolution of psychical life, by Dr. M. Borowski; further, an exposition of evolution in art, by Dr. W. Tatarkiewicz; and, finally, an inquiry by Dr. Fl. Znaniecki into the meaning of evolution of man and of the universe.

The present volume closes a large circle of ideas developed in the three first volumes which, after an introductory treatment of the concept of evolution in general, bring the (advanced) private student face to face with the facts and problems of universal and terrestrial evolution, of the evolution of plants, animals and man, of human civilisation, of language and economic life. The "Guide" proper (series I.) consists of several independent volumes covering the needs of the self-educator in the departments of mathematics, natural sciences, philology and history, sociology and law, and philosophy.

It may not be out of place to mention that the whole publication, which, since 1898, has been circulated in many thousands of cheap but beautiful volumes, is entirely supported by the Mianowski-Fund, a national institution of great social utility, and by the disinterested labours of the editors.

L. SILBERSTEIN.

Crystallography: an Outline of the Geometrical Properties of Crystals. By Prof. T. L. Walker. Pp. xiv+204. (New York: McGraw-Hill Book Co., Inc.; London: Hill Publishing Co., Ltd., 1914.) Price 8s. 4*d*. net.

THE theodolite form of goniometer was invented, and the advantage of determining the position of a face on a crystal by a pair of co-ordinate readings of a single setting was pointed out almost simultaneously by a German, Goldschmidt, and a Russian, Fedorov. The method had, however, been used some years before by an Englishman, Miller, but the posthumous paper in which it was used escaped general notice. It is, however, largely due to the teaching of Goldschmidt and the series of researches carried out by him and his pupils that the convenience of the two-circle measurement of crystals has become widely recognised.

Prof. Walker is imbued with the Goldschmidt spirit, and essays in the volume before us to remove the reproach that no text-book on crystallography written in the English tongue is based on that method. We think that his effort has been crowned with but qualified success. The discussion of the different classes of crystal symmetry and the types of symmetry characterising each, which occupies the greater part of the book, follows the ordinary, old-fashioned lines, even to the use of the Millerian indices, and the author has wisely refrained from complicating the discussion by devising a brand new set of names for the several classes. The sections on the Goldschmidt method are, on the other hand, scattered throughout the book; it would have been wiser to collect them together and to have expanded them. The argument is incomplete. For instance, the fundamental property of the gnomonic projection, viz., that all zones are represented by straight lines, is very indefinitely stated, and not proved at all. Examples of working out crystals belonging to the six systems should have been included in the several chapters, instead of reprinting more or less fully at the end of the book a few original papers, in which the actual working is subservient to the interest of the particular research. For a full understanding of the Goldschmidt method the student must still refer to the original source.

We are informed that the Hill Publishing Co., Ltd., are the London publishers, but their name is not given on the title-page.

First Book of Physiology and Hygiene. By Gertrude D. Cathcart. Pp. vi+158. (London: Macmillan and Co., Ltd., 1914.) Price 1s. 6*d*.

IT is apparently the notion in certain educational circles that hygiene can be taught without a preliminary knowledge of the science physiology on which it is founded. If such an idea still lingers anywhere it will be immediately dispelled by a perusal of this attractive little book. The author shows quite clearly that the laws of health are direct deductions from physiological principles. These are explained in clear, simple language, so free as possible from technical terms, and we can highly recommend the book as suitable for readers commencing the study of the subject, or for those who do not wish to take it up from the professional and medical point of view. Where so much is excellent, it seems ungracious to point out a serious mistake, the only one so far as can be ascertained; this is the erroneous statement that the red blood corpuscles are the carriers of carbon dioxide.

W. D. H.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Density of Lead from Ceylon Thorite.

LAST May, in conjunction with Mr. H. Hyman, I published the result of an examination of the relative atomic weight of a small specimen of lead, less than one gram, separated from a kilogram of Ceylon thorite, which showed a value rather more than a unit in excess of that found for a specimen of ordinary lead. I have since been engaged in extracting the lead from 33 kilograms of Ceylon thorite, which was first carefully sorted by hand, piece by piece, into various grades. From the finest grade, consisting of 20 kilograms, about 80 grams of lead were obtained, in agreement with the percentage obtained by analysis.

This specimen, and a similar weight of ordinary assay lead, have been carefully purified by identical processes, and finally obtained as metal, by fusing the oxide with cyanide, and repeating the fusion with the metal. The very porous castings so obtained were melted in a mercury pump vacuum in glass tubes with drawn-out jets, and cast into cylindrical graphite moulds in the vacuum, hydrogen to atmospheric pressure being then admitted, and the lead allowed to freeze from the bottom.

It was thought that a determination of the specific gravity would yield results of interest. It is to be expected that the atomic volumes of isotopic elements should be identical, so that, on this view, the densities should be in proportion to the atomic weights. The density of lead distilled in a vacuum was found, by Kahlbaum, Roth, and Siedler, to be 11·3415 ($D^{20°}_{4°}$), and after pressing to 10,000 atmospheres, 11·3470. For the ordinary lead, prepared as above detailed, $D^{20°}_{4°}$ was found to be 11·3465, as the mean of three determinations agreeing within 8 units in the last place, in good accord with that found for distilled lead. On the other hand, the value found for the specimen of thorite lead was 11·376, which is 0·26 per cent. greater, and higher than has been found previously in any trustworthy determination. The atomic weight calculated from the density, taking 207·10 as the figure for ordinary lead, is 207·64. It remains to be seen whether the constants of the lead will be altered by further purification, but one would expect that the effect of any possible impurity would be to decrease, rather than increase the density.

During the purification of the lead, bismuth was specially looked for, but, if any at all was present, its quantity was certainly less than one part in ten millions of the mineral. This seems to dispose of the speculation that bismuth is one of the end products of the thorium disintegration. On the other hand, I was surprised to find a perceptible quantity of iodine in the mineral, and separated between one and two grams, which Mr. J. A. Cranston is now examining. So far as the tests have yet gone, there seems to be a distinct trace, also, of thallium present.

FREDERICK SODDY.

Chemical Department, Aberdeen University,
January 30.

The Cause of Streaks upon Lath and Plaster Walls.

IN reply to Mr. Thomas D. Cope's letter in NATURE of January 21, it may be stated that he is correct in supposing that the best explanation of the streaks on the plaster he refers to is that they are due to the hot-air molecules driving the dust particles into contact with the plaster, and the colder the plaster the weaker is the power of the cold-air molecules next it to resist the deposition. This tendency of hot air to deposit its dust on cold surfaces can be seen in a very marked way in any house heated with hot water or steam. Wherever a hot pipe comes through a wall there will always be found a dirty vertical streak on the wall just above the hot pipe, caused by the stream of hot air rising from the pipe depositing its dust on the cold surface.

This action of hot air on cold surfaces accounts for the difference in cleanness of surfaces in rooms heated by open fires, and those warmed by hot air or by the so-called radiators, which do most of their heating by warming the air by contact. In a fire-heated room the furniture is principally heated by radiation, and, being warmer than the air, it repels the dust; while if heated by hot air, the air heats the furniture, and in so doing deposits its dust on it. These remarks apply to the fine dust, and not to the larger particles which fall on the furniture, and do not adhere to it like the heat-deposited ones. Electric lighting keeps the ceilings much cleaner than gas. Much of this cleanness is due to the much lower temperature of the air rising from the electric bulb than from gas-lighting, but ceilings over electric lights show blackening, especially in smoking-rooms.

The cause of the streaks on plaster referred to by Mr. Cope may, however, be a little more complicated than stated above, because the plaster is porous, and some amount of diffusion will take place between the gases in the room and those at the back of the plaster, and as the laths will reduce the diffusion their action will, to some extent, aid their heat-conserving effect. The principal cause of the streaks would, however, appear to be the heat effect, as it will be generally found that, if the heating and other conditions are the same, the ceilings of the rooms on the top flat of a house are much more lath and beam marked than those underneath, owing to the upper surface of the plaster in the upper rooms being exposed to the cold air under the slates while the ceilings of the lower rooms are kept warmer by the rooms over them.

It is possible the difference in the plaster in the cold room referred to by Mr. Cope may be due not to any action of the water vapour, but to its condensation on the walls ingraining the dust into them.

The reply to Mr. Cope's last question is, yes. A reversal of the phenomenon is quite simple, and has already been referred to. Any surface hotter than the air keeps free of dust; a surface placed in a smoky chimney, if it is hotter than the gases, gets no soot deposited on it. A paper bearing on the above subject, and entitled "The Formation of Small Clear Spaces in Dusty Air," appeared in the Trans. Roy. Soc., Edin., xxxii., part ii.

In my letter in NATURE of January 21, the date of a letter there referred to is given as March 16, 1913, which should have been March 6, 1913.

JOHN AITKEN.

Ardenlea, Falkirk, January 26.

THE cause of these streaks, which are also often to be seen on ceilings, appears to be due to the fact that bodies which are warmer than the atmosphere are surrounded by a "dust-free space," and that dust is battered upon surfaces which are cooler than the atmosphere.

The dust-free space has been described by Tyndall ("Dust and Disease," Royal Inst., 1870), Frankland ("Dust and Disease," Proc. Roy. Soc., vol. xxv., p. 542), Rayleigh (Roy Soc., December 21, 1882; NATURE, vol. xxviii., p. 139), Aitken (Roy. Soc. Ed., January 21, 1884) and Lodge and Clark (*Phil. Mag.*, March, 1884, p. 214).

Recently I have discussed the question of the discoloration of walls and ceilings (the *Engineer*, July 3, 1914) in an article on the "Theory of the Radiator."

In the above papers your correspondent will find answers to the questions he puts. R. M. DEELEY.

Abbeyfield, Salisbury Avenue, Harpenden,
January 22.

Adelard of Bath and the Continuity of Universal Nature.

IN the recently published volume of "Roger Bacon Commemoration Essays" (1) Prof. Pierre Duhem's contribution, "Roger Bacon et l'Horreur du Vide," has for its main thesis that Bacon was the first to formulate a theory of universal continuity; an incorrect hypothesis, it is true, but one which Prof. Duhem believes to have served the useful purpose of supplementing "the peripatetic theory of heavy and light" until the discovery of atmospheric pressure. This theory developed in connection with certain problematical phenomena of which this "experiment" is the chief and typical case. If there is suspended in air a vessel of water having a hole in the top and several narrow apertures in the bottom, no water will fall from it so long as the superior aperture is closed. Yet water is heavier than air, and according to the principle of Aristotle's physics should fall to the ground. Writers before Bacon, according to Duhem, explain this anomaly by saying that the fall of the water would produce a vacuum, and that a vacuum cannot exist in nature. But Bacon argues that a vacuum cannot be the reason why the water does not fall, because a vacuum does not exist; he then explains further that although by their particular natures water tends downwards and air upwards, by their nature as parts of the universe they tend to remain in continuity. Duhem holds that Bacon was the first to substitute this positive law of universal continuity for the mere negation that a vacuum cannot exist in nature (2).

Prof. Duhem supports his case by citation of Greek, Byzantine, and Arabian sources, and by use of writings of fourteenth-century physicists available only in manuscripts. But unfortunately for his main contention he has overlooked that remarkable little treatise, "Questiones naturales," which Adelard of Bath, Bacon's countryman, wrote more than a century before Roger penned his "Questiones naturales" (3). In Adelard's fifty-eighth chapter his nephew says—the work takes the form of a dialogue between Adelard and his nephew—"There is still one point about the natures of waters which is unclear to me." He then asks his uncle to explain a water jar, similar to that just described, which they had once seen at the house of an enchantress. Adelard replies in his clear, easy style, so different from the scholastic discussion in Bacon's corresponding passages:—

"If it was magic, the enchantment was worked by violence of nature rather than of waters. For although four elements (4) compose the body of this world of sense, they are so united by natural affection that, as no one of them desires to exist without another, so no place is or can be void of them. Therefore immediately one of them leaves its positio another succeeds it without interval, nor can one leave its place unless some other which is especially attached to it can succeed it." Hence it is futile to give the water a chance to get out unless you give the air a chance to get in. Finally, Adelard not only thus anticipates the theory of universal continuity, he describes what actually occurs in the "experiment" more accurately than Bacon or the other physicist cited by Duhem. "Hence it comes about that, if i a vessel which is absolutely tight above an apertur is made below, the liquid flows out only interruptedl and with bubbling. For as much air gets in a liquid goes out, and this air, since it finds the wate porous, by its own properties of tenuity and lightnes makes its way to the top of the vessel and occupie what seems to be a vacuum" (5).

LYNN THORNDIKE.

Western Reserve University, Cleveland,
Ohio, U.S.A.

(1) Edited by A. G. Little, Oxford, 1914.

(2) Bacon Essays, p. 266. "Le doctrine dont nou avons suivi le développement au travers des écrits Roger Bacon semble bien lui appartenir en propr

A peine, croyons-nous, en avait-il trouvé chez ses prédécesseurs un germe presque infime," etc.

(3) For the dates of Adelard's life and writings see C. H. Haskins in the *English Historical Review*, vol. xxvi., p. 491, and vol. xxviii., p. 515 (July, 1911, and July, 1913).

(4) Adelard elsewhere in the treatise explains that the earth, air, fire, and water which we see and feel are not the elements earth, air, fire, and water, but compounds.

(5) The following is the complete Latin text of the chapter. I have used both the printed edition in the British Museum, where the text is sometimes faulty, and the twelfth-century manuscript in the Eton College Library, which is possibly the autograph. The chapter heading reads, "Quare ex vase pleno inferius aperto aqua non exeat nisi prius superius foramen aperiatur." The text then begins:—

"Adhuc mihi de aquarum naturis quiddam dubitabile restat. Cum enim tempore ut scis iam preterito anum prestigiosam studio incantationis discende addissemus ibique anilibus imbuti sententiis nescio an sentibus aliquot diebus moraremur, eadem in domo vas quoddam mirabilis efficacie ad horas prandiles afferebatur. Quippe cum idem et superius et inferius perforatum multipliciter foret, aqua etiam ad manus abluendas infusa, dum minister aquarius superiora foramina pollice obturabat, nichil aque ab inferioribus emanabat, ablato a superiore pollice statim nobis circumstantibus per inferiora foramina aqua redundabat. Quod ego, ipsum prestigium esse putans, quid mirum, inquam, si anus dominica incantatrix est cum aquarius servulus monstra pretendat. Tu vero more tuo, quoniam incantationibus studiosus eras, minime illi rei vacare dignatus es. Nunc igitur quid de aqua illa sentis aperta; semper erant subteriora foramina et nichil tamen nisi ad aquarii arbitrium fluebat.

(A) Si prestigium id erat, nature potius quam aquarum violentia id incantatum est. Cum enim huius mundi sensilis corpus quatuor elimenta componant, ita ipsa naturali amore conserta sunt ut, cum nullum eorum sine alio existere velit, nullus locus ab eis tum vacuus sit tum esse possit. Unde fit ut, quamcito illorum unum a loco suo cedat, aliud absque intervallo eidem succedat, neque potest a loco cedere, nisi aliud quod substantiali quodam affectat amore possit ei succedere. Clauso igitur introitu succedentis frustra patebit exitus succurrentis, hoc itaque amore hac expectatione in cassum aquae reperies, nisi introitum aeri prestes. Haec enim, ut supradictum est, cum non pura sint, ita coniuncta sunt ut sine se esse non possint vel nolent. Unde fit ut, si in vase superius penitus integro inferius fiat apertio, non nisi cum intervallo quodam et quasi cum murmure liquoris fiat effusio. Tantus enim aer intercedit quantum inde liquoris exit, qui quidam cum ipsam aquam porosam inveniat innativa sibi et tenuitate et levitate penetrando superiorem vasis locum qui vacuus videtur occupat.

LYNN THORNDIKE.

The Economic Status of the Blackcap.

IN NATURE of January 7 Mr. W. E. Collinge (for whose work I have the greatest respect) places the blackcap in his list of injurious birds. As at once a gardener and an observer of birds for about sixty years I wish to protest against this accusation, which, if acted upon by fruit farmers, would soon lead to the extinction of the most charming songster of all the true warblers.

I grant that it eats small fruits, especially raspberries, but I contend that the insects it destroys must, from the economic point of view, fully counterbalance these depredations. This, of course, cannot be proved, because all the insects it devours are not injurious, and the proportion of these will vary in each locality, but considering that the blackcap arrives in this country early in April and does not leave until September, while the season for small fruits lasts practically only from the beginning of July to the middle of August, we have about sixteen weeks when it has to live on insects to six weeks of fruit eating!

Mr. Collinge rightly says that the bird is "not plentiful" (p. 510), but adds that it has considerably increased in numbers during the last eight or nine years (p. 511). To this I must entirely demur—certainly as regards this part of Kent, where much small fruit is grown. It is a bird the clear melodious song of which cannot be overlooked, and as I have been on the look out for it every spring for the last thirty years at least, I am perhaps as competent to form an opinion on this point as Mr. Collinge. I have never more than one pair in my garden, and rarely hear the bird elsewhere. I should say it is not as abundant here now as it was twenty years ago at Colwyn Bay, where I then lived.

ALFRED O. WALKER.

Ulcombe Place, Maidstone, Kent, January 26.

I REGRET quite as much as Mr. Alfred O. Walker to have to condemn the blackcap, but in an investigation of this kind one must always be careful not to allow sentiment or preconceived notions to bias one's opinion.

I have ample evidence that this bird has increased in numbers, at least in the midland counties, during the past six or seven years. I cannot speak for Kent. As to the nature of its food, an examination of the stomach contents of thirty-three adult and four nestling birds showed that the bulk of the food consisted of fruit and peas; there were a few aphids, twenty small lepidopterous larvæ, and the remains of seven beetles. Out-of-door observations made during the past ten years add still further evidence of the injuries these birds will inflict upon wall fruit, currants, strawberries, blackberries, raspberries, peas, etc. During the summer of 1913 I had ample proof in my own garden of the havoc four or five birds can commit on peas.

Mr. F. Smith, of Maidstone, a large fruit-grower and a careful observer, stated in a paper published in 1906:—"A family of blackcaps in a cherry orchard commit grave havoc. They do not eat a quarter of the fruit they pick, and they are also very fond of raspberries and figs. It is the worst summer bird we have in the fruit plantations." This opinion has been confirmed by fruit-growers in all parts of the country.

Where this species is not plentiful or in non-fruit-growing districts, it may be left alone, but in fruit-growing districts it should not be allowed to increase, further, as I stated in 1913, "any attempt at protection will justify fruit-growers in taking vigorous measures for extermination."

WALTER E. COLLINGE.

8 Newhall Street, Birmingham.

Names in Mechanics.

IN the current number of NATURE Sir Oliver Lodge refers to the usefulness of naming units, and many of us remember what a clearing up of ideas resulted in the student's mind from the substitution of the term "radian" for the circumlocution "unit of circular measure." I wish to ascertain any names that have been proposed for units in mechanics, and have attained little or no vogue; as instances "velo" and "celo" may be mentioned, which were proposed as names for the units of velocity and acceleration. I wish also to know how far Prof. Perry's "slug" is in use. Can any reader of NATURE help me?

DAVID MAIR.

NOTES ON STELLAR CLASSIFICATION.

II.

IN the first series of notes[1] I stated how I was trying to find whether a combination of the meteoritic hypothesis and my system of *chemical* classification of stars into two series of ascending and descending temperatures might land us in a method of detecting *physical* differences. The importance of this inquiry depends upon the fact that any system of *chemical* classification along one line must land us in confusion, seeing that equal or nearly equal temperatures, and therefore chemistry—for chemistry is the child of temperature—mark two very different physical states in the life of a star in its progress from nebula to extinction as a cold solid globe.

In order to show the method of attack I give here a diagram showing my classification and that of Harvard (H.3) based upon chemistry. The Harvard symbols given are those of the type stars used in my classification, but the letters B, F, K, etc., are generally used alone.

The difference in physical state assumed on the meteoritic hypothesis is indicated by the wide dotted curve to represent nebulous conditions at the bottom of the ascending arm, and the firm dark line to represent condensed stars at the bottom of the descending one.

I first deal with the evidence of bright lines in certain chemically classified stars as constituting a difference from the normal stars in which bright lines do not occur. The inquiry will show us the stellar species in which these bright lines occur.

In 1876 I suggested that bright lines in stellar spectra might be added to a dark line spectrum by our spectroscopes revealing to us the presence of a gaseous envelope above the most valid absorbing region.[2] I believe Pickering was the first to see such an envelope, and it has been seen since by others.

How such an envelope can strengthen its story when its temperature is increased is shown in a valuable table given in Miss Cannon's catalogue.[3] There we find eighteen stars in which bright $H\beta$ alone is superposed on the absorption line in eight stars. In the others $H\gamma$ is added in ten cases. In six stars we get $H\delta$ added to $H\beta$ and $H\gamma$. In one star we get a fourth line, $H\epsilon$, added to the preceding three. As lines are added the intensity of the earlier lines is increased. The extreme case is μ Centauri, where the intensity of the hydrogen lines is ϵ 2, δ 3, γ 6, and β 10. In some cases the bright lines are variable, but the same law holds; the work always begins at the red and decreases towards the violet (Fig. 2).

But this is not all the story. In μ Centauri, where we get the greatest development of the bright hydrogen, there are other lines. All these lines but one are enhanced lines—and of iron!

Among the facts to be borne in mind in considering these questions are those revealed by the recent study of the Madrid photographs of the recent Nova (Geminorum 2), recorded in the last volume of Kensington researches.

The photographs showed a well-marked stage as the Nova cooled down, principally indicated by a bright line near λ 4640 (4639·2); and it was further noted that in previous Novæ the appearance of this line preceded that of the ordinary nebula line near λ 500, and further that it was the brightest line in the whole spectrum where $H\beta$, $H\gamma$, and λ 4472 were visible.

The 4640 line has been noted in several planetary nebulæ, and among the bright lines of the Wolf-Rayet stars not yet chemically classified.

This line is associated in Novæ and elsewhere with another at λ 4688, not produced by the same substance for the lines vary inversely; it also is frequently seen in the Wolf-Rayet stars.

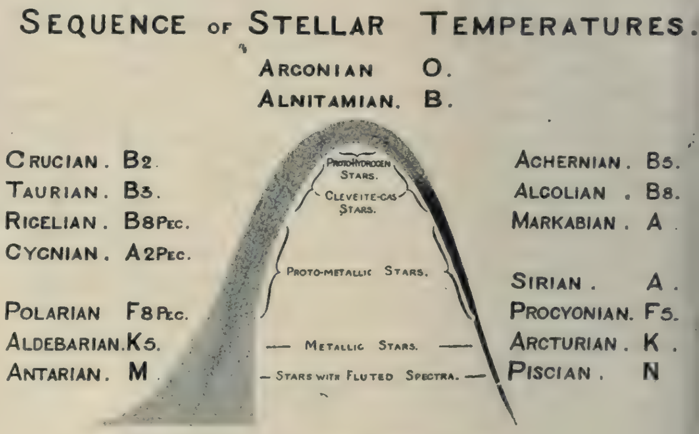

FIG. 1.—The temperature curve.

We seem justified, then, in assuming, to begin with at least, four stages of bright lines:—

$H +$ enhanced lines
$H + 4688$
$H + 4640$
lowest temperature $H + 500$.

and these are common to the stellar envelopes and novæ.

If we include P Cygni, we find another change,

highest temperature $H + He +$ lines of $O + N$.

Of the substance which produces 4640 we know as yet nothing, but it is possible that 4688 represents carbon, of the existence of which in nebulæ and the Wolf-Rayet stars there is evidence.[4]

On the other hand, in 1905[5] Mr. Baxandall and myself recorded a line at λ 4685·97 in the spectrum of a helium tube, and its occurrence in stars was noted. This would be another origin.

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[1] NATURE, November 12, 1914.
[2] See Proc. Roy. Soc., 1878, p. 49.
[3] Harvard Annals, vol. xxviii., part ii., p. 228.
[4] See especially my paper in Proc. R.S., vol. xlvii., p. 40, 1889.
[5] Proc. Roy. Soc., vol. lxxiv., p. 546.

proto-helium. A further inquiry on this subject is necessary, and is under way.

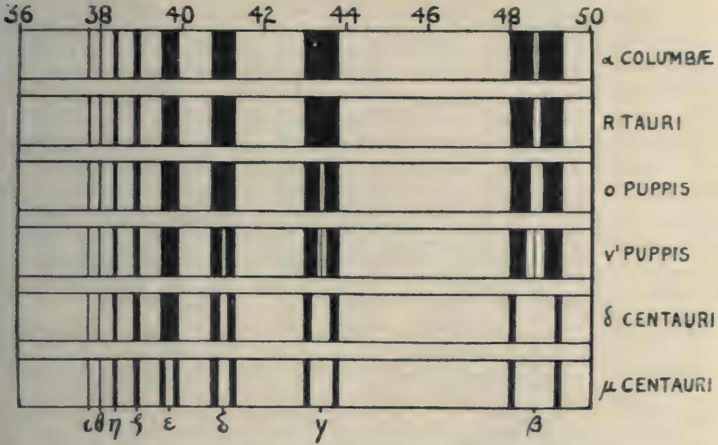

FIG. 2.—Showing how bright hydrogen lines of the stellar envelope make their appearance superposed in the dark absorption lines produced by the subjacent atmosphere or photosphere. This also occurs from the least refrangible side, extending to the blue end as the intensity increases.

It is clear from the above that bright lines have a way of their own, and that the absorption lines and the bright lines have to be studied separately.

It must also be stated that in the majority of non-variable stars with bright lines, the absorption lines have not yet been sufficiently studied to allow of their chemical classification.

I next come to a different origin of bright lines studied in some variable stars. The variability of these is due to a brightening of the continuous spectrum and *the appearance of bright radiations*, at maximum. I have previously (Bull. I.) referred to my hypothesis that these are produced by collisions between meteor swarms.

The simplest case is represented by a swarm B (Fig. 3) revolving round A and colliding at periastron. The light curve of the variability thus produced is represented in the middle part of

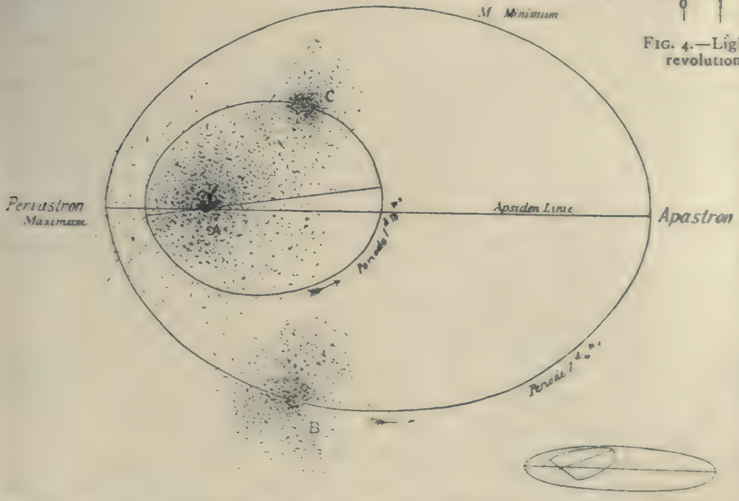

FIG. 3.—Orbits of two meteor swarms B and C round their primary A, colliding at periastron.

Fig. 4, a rapid ascent followed by a slower descent, and the curve is smooth.

The illustrations are taken from Dr. Lockyer's memoir on the variability of η Aquilæ.

In a less simple case, there is a third swarm, C, involved, with a much shorter period than that of B. The combined curve is no longer smooth.

What, then, is the actual physical condition of these two sets of stars with bright lines? In order to answer this question and to test the collision theory in the case of the variables, we must know whether their temperature is rising or falling.

A set of diagrams has been prepared by Mr. N. K. Johnson showing the Harvard and Kensington classifications, the former, except at the bottom, common to the two arms of the temperature curve, which is indicated by two vertical lines and a connecting horizontal line at the top.[6]

To use these we may begin by taking the case of the constant bright line

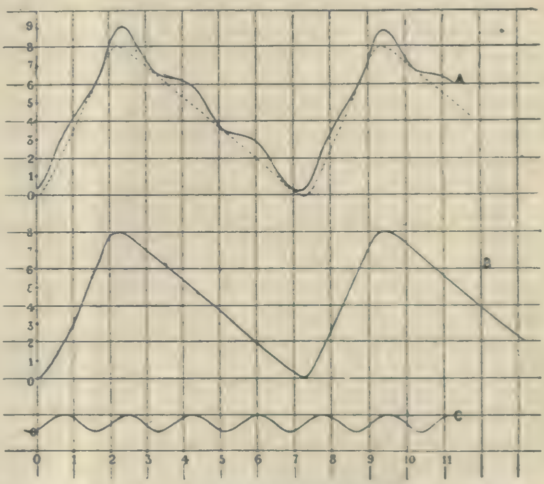

FIG. 4.—Light curves. B, produced by revolution of B: C, produced by revolution of C; A, compound curve produced by both revolutions.

stars, omitting the Wolf-Rayet stars. Of the thirty-eight stars given in the revised Harvard photometry, twelve, indicated by crosses, are included in my classification. All these are near the top of the temperature curve. There is a fair assumption then that the other twenty-six stars may follow suit—that is, that they probably belong to the species which include the twelve; in the absence of a complete classification, therefore, inquiries involving their physical state will be safer in accepting this assumption than in neglecting it.

NORMAN LOCKYER.

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[6] The original temperature curve contained gaps below the Cygnian and above the Sirian types for two other possible classes, but these are omitted in the diagrams.

TRINITROTOLUENE IN THE WAR.

IN a recent article in NATURE (December 24, 1914), brief reference was made to the high explosives used as bursting charges for shells, the most important being the much-discussed trinitrotoluene, used largely by the Germans. The following summary of an able contribution on the subject, published in the *St. Thomas's Hospital Gazette* for December, will prove a useful supplement to the previous article in our columns.

Few people realise the exacting conditions which a high explosive for shells must fulfil; these may be summarised as high bursting power, stability in storage, insensitiveness to shock on firing from the gun and on impact of the projectile, where it is desired that penetration shall precede bursting. Yet it must be possible to cause the material which withstands such drastic treatment to detonate when required with frightful violence. It is a case of reconciling the irreconcilable. Further points are safety in handling in the shell factory and the suitability for producing maximum density of loading, say by some such method as melting and pouring into the shell.

The brisance, or bursting power, is shown to depend on the potential energy of the explosive, the velocity of detonation, and the degree of concentration (density of loading).

It will be realised that few substances will fulfil such conditions, and the number will be still further reduced by difficulties and cost of manufacture. The paper discusses the four most important explosives which have been tried for this purpose, namely, picric acid (lyddite), trinitrotoluene (TNT), tetranitromethylaniline (tetryl), and tetranitraniline.

The trinitrotoluene is the symmetrical isomer (1 : 2 : 4 : 6) melting at 80·6. It is manufactured by dissolving *ortho*nitrotoluene in concentrated sulphuric acid, nitrating first to the dinitro and finally to the trinitro stage, the purification being effected by recrystallisation from ethyl alcohol containing a little benzene.

Data are given of comparative trials of TNT and picric acid, both in France and Germany. In velocity of detonation and with the lead block test (increase in size of cavity on firing a charge) the advantage is with lyddite, as the following figures demonstrate:—

	Lyddite	TNT
Velocity of detonation	7745	7140 metres per sec.
Lead block test	228	218 c.c.

TNT caused, however, a greater displacement of earth than lyddite when fired in a bore-hole 1 metre deep.

> Except in the last instance, picric acid held a decided advantage throughout, and the question at once arises: Why, then, has trinitrotoluol been adopted by Germany, Russia, Italy, and other countries in preference to the picric acid that is still mainly used by us under the name of lyddite, and by France under the name of melinite? The struggle between the two explosives has been long and of doubtful issue, but it has now probably ended in the victory of trinitrotoluol.

In furnishing the answer to this conundrum the writer continues:—

> We have seen it to be inferior in regard to power, velocity of detonation, and density of concentration; its advantages lie in its greater insensitiveness to shock, its freedom from poisonous dust and fumes, the much lower temperature at which it can be poured into shells, and its chemical indifference to substances like lead and iron which are liable to form dangerous picrates. When firing a shell against a ship's armour, at certain limits of the thickness and toughness of the armour-plate and of the velocity of the shell's impact, picric acid would explode when trinitrotoluol would perform its work efficiently, and the latter is therefore better adapted to a high-velocity shell of large calibre.

Since TNT contains too small a percentage of oxygen for complete combustion, attempts to use it incorporated with bodies rich in oxygen, such as potassium chlorate, have been tried. The Belgian high explosive, "macarite," is stated to consist of 30 parts of TNT and 70 parts of lead nitrate. A very high density of loading is thus attained, but the velocity of detonation of macarite is given as only some 4600 metres a second.

In concluding his article, the author says that tetranitraniline or tetryl seem to be the only known substances that may supersede trinitrotoluol.

TYPHOID IN THE FIELD.

THE anti-vivisectionists, by their raging attack on the protective treatment against typhoid fever, have shown us, once more, the dark and ugly side of anti-vivisection. Kind people may try, but may try in vain, to find any excuse for such goings-on. The only possible sort of excuse for them is, that the treatment is not perfect, not faultless; and that, among some hundreds of thousands of men and women who have received it, a few—perhaps one in a thousand—have not done well. One in a thousand is a fair guess, founded on the experience of the 20,000 Valcartier men of the Canadian forces: but Surgeon-General Williams, Director of Medical Services, Australian Imperial Force, says of the protective treatment of 20,000 Australian troops, "Not one single case showed any after-symptom which could be considered worthy of consideration. . . . Not a man had to be taken off duty; drills and exercises proceeded as usual" (*Times*, January 30). Further, we may admit that the overwhelming rush of work, at the beginning of the war, may have caused, here or there, some error of judgment, or some neglect of this or that bit of technique. The strain on the Army Medical Department, the incessant overwork, were well-nigh intolerable; and it is more than likely that some men got the treatment without any precise directions how to take care of themselves after it, or even without much chance of taking care of themselves. If a man, for a couple of days after the treatment, will avoid over-exertion, and alcohol, and exposure to the danger of pneumonia, he may be confident that he will do well, and will have very little trouble from the treatment.

To admit this much is not to excuse the anti-vivisectionists; indeed, it makes their behaviour look blacker than ever. For example, they discover a case of pneumonia, coming on after the treatment, and forthwith they proclaim it as "septic pneumonia from inoculation." Or they discover a case of a bad arm after ordinary vaccination; this may have been the man's own fault; later he was discharged from the Army for a cause which had nothing to do with his arm. And forthwith they declare that the man's health was so impaired by the protective treatment against typhoid that he had to leave the Army. "Proved to be useless and dangerous"—that is the opinion—if we can call it an opinion—of these people. They are a very small handful of people, in proportion to the general public; but they are trying hard to prevent our men from being protected.

It is probable that some of them are incapable of clear thought on the subject. We may wonder what they will make of the statement just issued from the War Office, and published in Sir Frederick Treves's letter in the *Times* of January 26. Up to date, among our men abroad there have been thirty-five deaths from typhoid. Of these thirty-five men, thirty-four were not protected; it was two years or more since they had received any sort of protective treatment. Among our protected men there has been only one death, and this patient had only had a single dose of the protective treatment, instead of two doses as directed.

What will the anti-vivisectionists say to this? Which way will they look? Will they say that we do not know the proportion of non-protected to protected men throughout the Expeditionary Force? But we do know what strenuous and incessant efforts are made to avoid the sending out of non-protected men. Surely it is a safe guess that the great majority of the Expeditionary Force are protected. Nature leaves these alone; she picks out the non-protected. Two men shall be sleeping in one tent, fighting in one trench; the one shall be taken, and the other left. The anti-vivisectionists know that, lots of them; and we come back to Newman's saying, "Perhaps it is wrong to compare sin with sin, but I declare to you, the more I think of it, the more intimately does this *Prejudice* seem to me to corrupt the soul, even beyond those sins which are commonly called most deadly."

MR. F. W. RUDLER.

As announced with regret last week, Mr. F. W. Rudler died on January 23 at his residence, Tatsfield, Surrey, after a brief illness, in his 75th year. He will be lamented by a large number of scientific friends, who have known him not only as the genial curator of the Museum of Practical Geology, but also as a prominent member of many scientific societies and at the meetings of the British Association.

It was some fifty-five years ago that Mr. Rudler was appointed Assistant Curator of the Jermyn Street Museum. He rapidly made his mark as a mineralogist, and became more and more in request as a specialist in that department. In 1876 he was appointed lecturer in natural science at the University College of Wales at Aberystwyth; but in 1879 was recalled to succeed Mr. Trenham Reeks, as Registrar of the Royal School of Mines and Curator of the Museum of Practical Geology, which post he held until his retirement in 1902, when the high appreciation of his services was marked by the bestowal upon him, by King Edward, of the Imperial Service Order.

Beyond his official duties, Mr. Rudler was a busy worker and a voluminous writer. He was at different times president of the Anthropological Institute, also of the Geologists' Association and of the Essex Field Club. He was for years an active member of council of the Geological Society, and was awarded the Lyell Medal of the Society in 1903.

Mr. Rudler's popularity as a science lecturer caused him to be much sought after. His writings were largely in connection with technical works, such as "Ure's Dictionary of Arts and Manufactures," "Thorpe's Dictionary of Applied Chemistry," "Muir's Dictionary of Chemistry," the "Encyclopædia Britannica," etc. Articles and reviews flowed from his pen in a continuous stream for years, and he will long be remembered as a man of wide scientific attainments and high literary ability.

NOTES.

The committee of users of dyes appointed to confer with the Board of Trade as to a national dye scheme has come to a unanimous decision in favour of the adoption of a scheme which differs in certain important respects from those of the scheme previously made public. The proposal is to form a company with an initial share capital of 2,000,000*l.*, of which 1,000,000*l.* will be issued in the first instance. The Government will make to the company a loan for twenty-five years corresponding to the amount of share capital subscribed up to a total of 1,000,000*l.*, and a smaller proportion beyond that total. The Government advance will bear interest at 4 per cent. per annum, payable only out of net profits, the interest to be cumulative only after the first five years. In addition, and with the desire of promoting research, the Government has undertaken for a period of ten years to make a grant to the company for the purposes of experimental and laboratory work up to an amount not exceeding in the aggregate 100,000*l.* The modified scheme has been received with more approval from users of dyes in Leeds and the district than the original scheme, and the feeling appears to be general that it will meet with a considerable measure of success. The grant for scientific research in connection with the manufacture of dyes is a particularly satisfactory provision of the new scheme.

The relation between science and industry in this country has been the subject of a number of letters and articles in the daily papers recently, but the real difficulties of the situation from the scientific point of view have not usually been explained. Prof. J. F. Thorpe, however, in the *Times* of February 2, states clearly what the national needs are in this matter. It is often supposed that when business men decide what substance they wish to obtain all the chemist has to do is to look up the details of the preparation of the substance in the German patent literature and then to proceed in the same manner as a chef would do if he wished to make some new kind of pudding. This point of view is due to an entire lack of understanding on the part of the non-scientific person of the principles underlying scientific processes. Essential details are carefully excluded from patent specifications, and it is safe to say that an independent worker would, in most cases, have to devote some months to experiments on the scientific scale before he could find the correct conditions for applying a process to the commercial scale. Prof. Thorpe pertinently remarks in concluding his letter:—"Do the Government imagine, therefore, that any works research laboratory is going to solve these problems and adapt them to commercial conditions within any reasonable period of time? If they do, thev are greatly mistaken. The object *can* be achieved, but only by enlisting the services of every trained organic chemist in this country. The Government must organise the knowledge and skill which is, from the industrial point of view, now wasting in our universities, university colleges, and technical schools; moreover, it is only by a scheme such as this that the nation will be able to pick out those men who are fitted by temperament to be directors of commercial processes."

It is a fine instance of taking things quietly that the Rev. W. M. L. Evans, rector of Saxby, in North Lancashire, should write to the *Times* of January 28 pointing out that the pheasants of the parish were very much excited on the morning of Sunday, January 24, when the naval engagement was in progress. From the way in which the pheasants were "all over the place with their fuss," the clerk of Saxby inferred "there be rare goings on in the North Sea the morn." Without precise records of hours, observations of this sort are not of much scientific value, but they suggest that those who have time and are familiar with the normal ways of birds should keep an eye on similar occurrences. It is well known that birds have a quick and discriminating sense of hearing, and there is nothing essentially improbable in supposing that the Saxby pheasants heard news which failed to reach the parishioners. Several correspondents describe in the *Times* of February 1 observations in support of Mr. Evans's account of the disturbance of pheasants by the North Sea cannonade; and instances are given of similar effects produced on the birds upon other occasions and in other places, including New Zealand, by distant explosions and earthquakes. It may be premature to believe in the extraordinary sensitiveness of the Saxby pheasants, and the case is not strengthened by a reference to the geese of the capitol, but critical and comparative observations on the sense of hearing in birds would be interesting. It is certain, said Bewick, "that nothing can stir in the night, nor the least or most distant noise be made, but the geese are roused, and immediately begin to hold their cackling converse." It should also be remembered that noises inaudible in one zone are sometimes perceived in another more distant.

In *Popular Astronomy* Prof. E. C. Pickering quotes some interesting letters from Profs. Backlund, of Pulkovo, and Schwarzschild, of Potsdam, with reference to astronomers and the war. None of the Pulkovo astronomers have been called to serve, but Prof. Backlund's son is in the Russian ranks, and of French astronomers, M. Croze, astrophysicist of the Paris Observatory, has been summoned, as well as the son of the director, M. Baillaud, who has six sons and sons-in-law in the war. On the German side, many young astronomers are in the field. Dr. Zurhellen and Dr. Kühl, who were with the eclipse expedition, have been interned in Russia; Dr. Münch, of Potsdam, is wounded and a prisoner in France. Prof. Schwarzschild writes that he is himself at Namur, conducting a military meteorological station in the interest of the German aeroplanes and dirigibles. Prof. Bauschinger, director of the Strasburg Observatory, is a temporary terminus commander in that city. The *Astronomische Nachrichten* contains announcements of the deaths in the ranks of Dr. J. Liebmann, astronomer at the Berlin Observatory; also of Dr. Adam Massinger, of the Heidelberg Observatory, his death cutting short an elaborate investigation of the nebulæ photographed at the observatory. Dr. Martin Matzdorff, assistant at the Strasburg Observatory, a young man of great promise, was killed at Ypres in November.

Doubtless further particulars will be available when the American mail brings over last week's technical papers, but in the meantime it is probable that the long-distance telephone record, namely, conversations between Washington and San Francisco, both *via* New York and Boston, is no more than the natural outcome of the gradual extension of telephone lines with "loading coils" on the Heaviside-Pupin principle. That the feat has been accomplished by means of a new device just invented by Prof. Pupin, as one might gather from the telegram sent by the New York correspondent of the *Times* last week, seems unlikely. The "loaded" telephone line from New York to Denver (a distance of 2000 miles) has been in use for some little time, and the extension of this to San Francisco (making a distance of 3000 miles) is known to have been under construction. Apparently, as an experiment, a considerable *détour* was made, no doubt over other "loaded" lines, and Jekyll Island (Georgia) was included in the circuit; the total distance telephoned over is given as 5000 miles—certainly a record. It is interesting to note that Prof. Graham Bell, the inventor of the telephone, and now more than eighty years old, was able to converse over the line. The *Times* correspondent regards the event as foreshadowing the day when New York can talk with London, but this is somewhat premature. Although this distance is far less than 5000 miles, yet the problem is a much harder one owing to the enormously greater electrostatic capacity of a cable as compared with a land-line. There is much in Prof. Fleming's prediction that telephony between England and America, when it comes, will first be by "wireless."

SOME anxiety has been felt as to the fate of M. le Chanoine Henri de Dorlodot, Professor of Geology at the University of Louvain, concerning whom his colleagues in this country had been unable to obtain information. They will be glad to learn that he is at Louvain, in excellent health, and that his house and museums are absolutely untouched.

A PUBLIC lecture on the present position of the atomic theory was delivered by Prof. J. W. Nicholson at King's College on January 21. The lecturer reviewed the work of Faraday on electrolytic conduction, the origin of our first perception of the ultimate charge *e*, and proceeded to a historical sketch of the evolution of modern ideas of the atom as a purely electrical structure. An account was then given of very modern work in connection with radio-activity, X-rays, and emission spectra, concluding with the probable structure and number of electrons present in atoms of the simpler elements, and the possibilities of a celestial evolution of the elements which are now disintegrating.

SINCE January 14 several earthquakes have been felt in Italy and elsewhere. Two after-shocks of the Avezzano earthquake were felt in Rome on January 18. During the night of January 18–19, three earthquakes occurred in the province of Cosenza (Calabria), some buildings in the village of Luzzi being slightly damaged. According to the *Times*, various observatories in Italy recorded an earthquake at 2.15 a.m. (1.15 a.m., G.M.T.) on January 27, which lasted ten minutes, and was more violent than that which destroyed Avezzano. As no further account has been published, this earthquake would appear to be the same as that registered in British observatories at about the same time. The West Bromwich seismogram suggests an origin distant about 1500 miles, probably in Turkey or Greece.

IN the issue of NATURE for July 10, 1913, (vol. xci., p. 483) particulars were given of the allocation by the Mansion House Committee of the Captain Scott Fund. It will be remembered that the allocation fell under three main headings: the provision for relatives, for the publication of the scientific results, and for memorials. In connection with the last-mentioned object it is now announced that the committee has entrusted the execution of a monument to Mr. Albert H. Hodge. The monument and the pedestal are to cost 7500*l.* The architectural portion is to be of grey granite. A site has been selected by the committee facing the Thames in the grounds of Greenwich Hospital. A bronze memorial tablet to be placed in St. Paul's Cathedral is being executed by Mr. S. Nicholson Babb.

THE director of the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, London, E.C., has kindly sent us further information upon the subject of the trade in birds' feathers between India and Germany, referred to in a note in NATURE of January 28 (p. 596). He reminds us that the "Report from the Select Committee of the House of Lords on the Importation of Plumage Prohibition Bill (H.L.) 1908," contains much information of interest upon the subject. The Select Committee reported that "it appears clearly from the evidence that the enactments of British Colonies and certain foreign countries, which provide a close season for wild birds, and of India, which prohibits their export, are to a considerable extent ineffective, partly on account of the open market in this and other countries. Mr. Todhunter, who attended on behalf of the India Office, showed the difficulties of preventing illicit exportation." The Report may be purchased, either directly or through any bookseller, from Messrs. Wyman and Sons, Ltd., Fetter Lane, London, E.C., the reference number being H.L. 137, and the price 6*d.* (ex-postage), or it may be consulted at the office of the Commercial Intelligence Branch of the Board of Trade.

IN the *Cairo Scientific Journal* for August, 1914, Mr. W. H. Harding King has collected a good budget of folk beliefs and songs from the western oases. The magical element is prominent in the beliefs of these people. When a child is born grain and salt are trundled about in a sieve to ensure the child against want; the pestle and mortar are beaten to make sure that he may not be frightened by any noise when he grows up; seeds are thrown about in the village as a charm to enable him to travel to any part of the world that he pleases, and the sieve is rolled about so that when he grows up he may run about quickly. When his finger nails grow long they are cut, and the ends of his fingers are dipped into newly ground flour to prevent them from growing again, and as the natives consider it unlucky to open a pair of scissors before the child's face, his nails are either cut behind his back, or bitten off by his parents. To protect trees from the Evil Eye and to ensure a good crop, a bone or the skull of an animal, or a piece of manure or a small doll-like figure are hung on the branches. Natives refresh themselves by stuffing the small pungent onions of the oases into their nostrils; onions which over night have been kept under the pillow are hung with the barley to bring refreshment to the family until the next season.

THE Herbert Spencer Lecture at Oxford last year was delivered on November 18, 1914, by the Hon. Bertrand Russell, on "Scientific Method in Philosophy," and has just been issued in pamphlet form by the Clarendon Press (1*s.* 6*d.* net). Mr. Russell's thesis is that it is from science rather than from ethics or religion that philosophy should draw its inspiration. In fact, scientific philosophy aims only at understanding the world and not directly at any other improvement of human life; and thus it cannot take account of ethical notions without being turned aside from that submission to fact which is the essence of the scientific temper. It is piecemeal and tentative like other sciences, and not like philosophy has been hitherto, where each philosopher had to begin the work again from the beginning. For further elaboration of the views on logic as the essence of philosophy and the foundations of physics, Mr. Russell refers to his book on "Our Knowledge of the External World" (Chicago and London: Open Court Publishing Co., 1914); reviewed in NATURE of November 12, 1914 (vol. xciv., p. 278). The adoption of scientific method in philosophy compels us to abandon the hope of solving many of the more ambitious and humanly interesting problems of traditional philosophy; but what it does solve it solves with great precision.

IN the *Revue Scientifique*, No. 1, 1915, an interesting summary is given by Dr. Landrieu of the use of tincture of iodine for the antiseptic treatment of wounds on the battlefield. Descriptions are given of several ingenious tubes by means of which the iodine may be carried and applied. Dr. Maumus, in the same journal, also gives an account of tetanus among the wounded.

WE have received the annual report of Livingstone College for 1913–14. This was the last session of the principalship of Dr. Harford, who has worked untiringly for twenty-one years. During this period 548 students have passed through the college, and have gone forth to all parts of the world. The college was instituted in order to give some medical education to missionaries, and it has well fulfilled its object. Mr. Loftus Wigram is the new principal.

WE have received as an excerpt from vol. iv. of the "Scientific Results of the Scottish National Antarctic Expedition" a report on the *Scotia* collection of Atlantic fishes by Mr. R. S. Clark. The fishes were collected between 40° N. and 36° S., near Azores, Madeira, Cape Verde Islands, Ascension, St. Helena, Cape Colony, St. Paul's Rocks, and their main interest is in increasing our knowledge of the geographical distribution of some species, *e.g.* at St. Helena. No new forms were found.

IN the January number of the Transactions of the Herts Natural History Society, Mr. J. Hopkinson gives a summary of the climate of Hertfordshire, based on general observations for twenty-five, and rainfall records for seventy, years. February, March, and April are the driest, and the months from July to November the wettest, October attaining the maximum in the latter respect. The minimum rainfall in any year at any one station during the period under review was 15·79, and the maximum 42·56 in.

BOTH the January and February numbers of *My Children's Magazine*, edited by Mr. Mee, contain admirable and well-illustrated natural history articles specially suited to juvenile readers. The subject in the January issue relates to insects serviceable to man; particular attention being directed to the collection and preparation of silk-cocoons in Syria. Reference is also made to a scarcity of flowers in the south of England, owing to the ravages of the bee-disease. The food-storing habits of various animals form the subject of the article in the February issue.

To vol. xxv., part 2, of the Bulletin of the American Museum of Natural History, Dr. R. Broom contributes an illustrated catalogue of type and figured specimens of Permian, Triassic, and Jurassic South African reptiles in the collection, as an instalment of the catalogue of the whole series of typical and figured fossil vertebrates in the museum. The South African collection, which is a particularly fine one, was mainly brought together by Dr. Broom himself. The publication is dated January, 1915, but it unfortunately contains the description of a new genus and species (*Youngina gracilis*) which had already been named in the fourth part of the Zoological Society's Proceedings for 1914, published in December last.

SOME fundamental morphological objections to the mutation-theory of de Vries, by Prof. E. C. Jeffrey, and the English black-and-white rabbit in connection with the question of Mendelian unit-character constancy, by Messrs. W. E. Castle and P. B. Hadley, form the subjects of two out of the three chief articles in the January number of the *American Naturalist*. In the former it is asserted that *Oenothera lamarckiana*, and other species of the same genus, which form the main basis of the de Vriesian mutation hypothesis, are (like other members of the Onograceæ) much contaminated by natural hybridism. The species of Œnothera are thus largely, if not wholly, cryptohybrids; and Bateson's objection to the genetical purity of *Oe. lamarckiana* is confirmed and also shown to be applicable to other members of the group. As hybridism is the best explanation of the behaviour of these species in cultures, it follows that the de Vriesian hypothesis, "so far as it is supported by the case of *Oe. lamarckiana*, is invalid."

IN an article on eugenics and the war, in the January number of the *Eugenic Review*, Mr. Theodore Chambers emphasises the all-importance in warfare of supreme care and attention in the treatment of the sick and wounded. In the old days, at any rate, the vastly greater proportion of the deaths in war were due to sickness; and although matters have immensely improved in this respect, "it is necessary to urge that even to-day far too little attention is being given by the nations which consider themselves the most civilised in the world to this aspect of war." Later on he observes that "from a military point of view, a voluntary army is probably far more efficient for its numbers than a conscript one. . . . One willing fighter is worth six pressed men." It is added that as universal training without conscription would raise the general physique of the nation, and in war-time would vastly increase the number of recruits for voluntary service, it is probable "that the best combination from the military and eugenic standpoints would be universal training with voluntary service for war."

THE Yale Peruvian Expedition has added a further contribution to our knowledge of Peru in the publication of an account of the Liverworts, by Dr. A. W. Evans, in the Transactions of the Connecticut Academy of Arts and Sciences, vol. xviii., of April, 1914. Many of the species come from the High Andes around Cuzco, and some from the forests of the eastern slopes. Of the thirty-one species collected, six were previously unknown. The paper contains good illustrations and useful notes on the geographical distribution of the several species, a small number of which are peculiar to the Andes.

A COMPREHENSIVE account of Sea Island cotton in the West Indies, recently issued by the Imperial Department of Agriculture as Pamphlet No. 74, forms a very trustworthy guide to those concerned in the West Indian cotton industry. The history of the industry is detailed, and chapters follow on the botany, cultivation, picking, and grading, examination of seed cotton and lint, insect pests, and diseases, etc. The pamphlet consists of 118 pages, and is very well illustrated, the general information has been selected with great care, and the compilers are to be congratulated on the preparation of so useful a manual.

THE story of the discovery of the fine cycad, *Encephalaitos Hildebrandtii* by Sir John Kirk, in Zanzibar and East Africa, and the transmission of specimens to Kew between the years 1868–78, forms an interesting contribution to Kew Bulletin No. 10, 1914. The story is told in extracts from Sir John Kirk's correspondence with Kew while he was acting as Consul-General at Zanzibar. Sir John's observations on the remarkable generation of heat in the male cones, made in 1878, are published for the first time; on one occasion a rise of temperature of as much as 16·5° F. was recorded.

THE compensation payable to tenant farmers for unexhausted manurial residues is mainly based on the tables drawn up by Hall and Voelcker with a view to their general application to stock of all kinds. It has been suggested by some valuers that special discrimination should be made in the case of pigs, on the grounds that the feeding of the pig differs greatly from that of other stock, and is largely restricted to the intensive feeding of young animals during the period of most rapid growth. In proportion to its weight the pig eats more dry matter and voids less dung than any other class of farm animal, so that a relatively high compensation value must be made for a relatively small weight of manure. In the current number of the *Journal of the Board of Agriculture,* Prof. Charles Crowther and Mr. A. G. Ruston describe an experiment designed to throw more light on this point. Two groups of pigs were confined in special pens, without litter, for periods of five days in each fortnight of the twenty-three weeks that the experiment lasted. All food consumed during the five days was weighed and sampled for analysis, but the excreta were collected only on the last three days of each period. There was a remarkably close agreement between the figures given by the two groups of animals, which showed an average weekly gain of 6¼ lb. per pig over the whole period of the experiment. The authors conclude that the manurial residues should not be credited with more than 25 per cent. of the nitrogen, 50 per cent. of the phosphoric acid, and 80 per cent. of the potash present in the foods. This means that the compensation allowance in the special case considered should be assessed at only three-fifths of that deduced from Hall and Voelcker's tables.

MR. E. H. CUNNINGHAM CRAIG, in a paper read before the Institution of Petroleum Technologists, has given a brief account of the prospective oilfields of Western Canada. This paper should be a welcome one as authoritative information upon the subject of these supposed oil regions is but scarce, although a number of wild rumours about one or other of them have been current for the last year or two. Unfortunately, Mr. Craig gives no very large amount of geological detail—probably there is not yet a great deal known definitely—but he shows that practically all the oil hitherto discovered in Western Canada comes from the Cretaceous formation, which is well, though irregularly, developed over a very large tract of country. He deals with three main areas, the Flathead and Pincher fields, the Calgary field, and the Vancouver area; the greater part of his paper is devoted to the second of these, which he appears to regard as decidedly promising, and he gives a full account of the wells that have so far yielded oil. Amongst these he describes the Discovery or Dingman well of the Calgary Petroleum Products Co., which has yielded an extraordinary water-clear oil, containing no less than 72 per cent. of benzine and capable of being used crude in the engine of a motor-car. It is evidently too early for any definite opinion to be pronounced as to the possibilities of Western Canada as a producer of petroleum, but Mr. Craig, who has studied the whole area very thoroughly, appears to be very hopeful as to its possibilities.

THE war and the weather during the first three months of the fighting is dealt with in the *Popular Science Monthly* for December by Prof R. deC. Ward, of Harvard University. The author points out the weather influence on war as one of the great controls to be reckoned with by every commander, and he likens the disregard of the weather factor to be about as serious as to forget to provide food, clothing, or ammunition. Some historical instances are given of the influence of weather on war. Mention is made of the weather controls being divided into two classes. In one the conditions are accidental, sudden, or unexpected, and in the other case the conditions are natural or normal, but not necessarily prepared for. The author says to know in advance the general climate of the war zone is very essential in planning a campaign or in organising a single engagement. From the nature of the despatches, he concludes that there was nothing in the meteorological conditions in August and in early September which had any noticeable effect upon the campaign. In mid-September constant reference was made to the difficulties caused by the heavy rains. The normal rains in September and October filled the trenches and often drove the troops out to fight with their bayonets, and the difficulty of moving heavy guns through the deep mud was a serious handicap to both armies, whilst the rivers were also flooded. The roads became quagmires, and in Galicia the soldiers were marching and camping in the snow. With the use of aeroplanes and airships modern warfare has been rendered more than ever dependent on the weather.

The Central for December, 1914, states that 174 former students or members of the staff of the City and Guilds College, Exhibition Road, South Kensington, are now on active service. The positions held by some of these are mentioned in the nine pages devoted to old students and their doings, which always forms one of the most noticeable and, to most readers, welcome features of the magazine. A well-illustrated article of exceptional interest is that by Mr. A. C. Cookson describing the work which falls to the lot of the maintenance department of a railway.

PART I. of the new volume of the Proceedings of the Physical Society of London extends to 117 pages. The president, Sir J. J. Thomson, opens the volume with the account he gave at the Cambridge meeting of the society of his attempts to produce radiations to fill the gap of about eight octaves between the softest Röntgen radiation and the shortest ultra-violet rays. His address as president closes the issue. It deals with the production and nature of the ions in gases. At the present time the interaction between ions and molecules appears to be explainable either by Maxwell's inverse fifth power law or by the law of impacts of hard spheres. Two papers are devoted to electrical questions—Mr. D. Owen's on an alternating-current bridge method of determining inductance in terms of resistance and capacity; and Mr. A. F. Hallimond's on the voltage ampere curves given by a great number of point contacts when the voltage applied to the contacts is gradually raised. The only paper on heat is Mr. Barratt's on the heat conductivities of a number of glasses, woods, and other bad conductors. Two papers deal with general physics. Mr. B. W. Clack gives the final results of his work on the diffusivities of salts in dilute solutions, and Prof. E. P. Harrison traces the effect of temperature on Young's modulus for wires.

IN the *Revue générale des Sciences* (vol. xxv., p. 777) M. Louis Brunet discusses the position of the combatant nations as regards the power of obtaining supplies of the metals copper, zinc, lead, tin, nickel, and mercury, which play so important a part in modern warfare. The conclusion reached is that the position of the Franco-Anglo-Russian alliance is far better than that of the central European empires, not so much on account of the greater producing power of the alliance, but owing to its mastery of the sea, which has enabled the English and French fleets to prevent in large measure the importation of metals declared "contraband of war" from neutral countries into Germany and Austria.

THE *Times* Engineering Supplement of January 29 gives an interesting account of aeronautics in 1914. Among other notable achievements of the past year are the British record of 135 miles an hour, heights of five miles scaled, or closely approached, by both French and German machines, and flights in seventy miles-per-hour winds by fliers who do not pretend to be "star-pilots." No fewer than nineteen persons flew together in one huge aeroplane of Russian make in 1914. One of our own Army-built stable aeroplanes has climbed at the rate of 1700 ft. a minute—a rate of ascent four times as fast as an express lift in an American hotel. Eight months ago Dr. Glazebrook gave, before the Aeronautical Society, a *résumé* of the experiments which had achieved stability—experiments vouched for by Colonel Seely, who verified them by making uncontrolled flights in person without any previous practice. Though Bryan and Harper had published their mathematical work in 1911, and Lanchester three years before that, it was only these telling practical outcomes of their work that brought these authors into their own in England during the past year.

OUR ASTRONOMICAL COLUMN.

WOLF-RAYET STARS AND THE PLANETARY NEBULÆ.—There are indications that these enigmatic bodies will shortly be fitted into the scheme of stellar evolution. Hitherto, whilst it was felt that they must be more or less related, actual evidence was of the slenderest. Prof. J. W. Nicholson was, however, led by his mathematical investigations of the spectra of *nebulium* and Wolf-Rayet stars to suggest that they were successive stages in the evolution of matter. Perhaps we can now say that this is an observed fact. The *Astrophysical Journal* for December (1914) contains some remarkable preliminary results obtained by Mr. W. H. Wright in the course of the spectroscopic examination of some planetary nebulæ possessing central condensations. A spectrogram secured with the 36-inch refractor (Lick), under exceptionally close following during a long exposure on N.G.C. 6572, showed *the spectrum of the nucleus* crossed by the bright nebular lines of the envelopes, and, moreover, in the spectrum of the nucleus appeared a band 17 Å. wide in place of the line λ 4686. These facts recalled the hitherto unique hydrogen envelope star of Campbell (BD+30° 3639). Detailed study of the spectrum of this body was then undertaken and, as was expected, the fact was established that the hydrogen envelope really gave the spectrum of a planetary nebula.

Here, then, are two cases of planetary nebulæ having nuclei which exhibit the spectra of Wolf-Rayet stars and, together with three other cases (N.G.C. 6826, N.G.C. Index 418, and N.G.C. 40) cited from unpublished observations by Merrill, Campbell, and Paddock respectively, the facts are held to justify the conclusion that such nuclei are in *all cases* Wolf-Rayet stars. The evidence does *not* establish the converse proposition that Wolf-Rayet stars are in all cases the nuclei of planetary nebulæ The author promises a more detailed account of the observations and also the early publication of a list of nebular lines. The materialisation of these promises will be eagerly anticipated

THE SOLAR ROTATION IN 1913.—In the current number of the Journal of the Royal Astronomical Society of Canada (September-October, 1914) Mr. H. H. Plaskett gives an account of the results of a study of the solar rotation which he and Mr. R. E. De Lury secured during 1913. The method was spectroscopic, and the region of the spectrum examined was λ 5600; thirty-one plates were utilised, on each of which were recorded nine rotation spectra; in these spectra displacements were measured for twelve lines. Tables summarise the measures and the results. The results are compared with those obtained for the same region of the spectrum in the years 1911 and 1912 by Messrs.

J. S. Plaskett and R. E. De Lury, using the same apparatus. The 1911 and 1912 values are found to be considerably greater than those obtained in 1913. A measurement of the 1913 plates by Mr. J. S. Plaskett results in the same values as those secured by Mr. H. H. Plaskett. The communication suggests the possible origin of the discrepancies, and discusses them individually. The author finally concludes that there is no evidence of systematic difference of velocity for different elements, and that at present it is impossible to settle the question of a variation in the solar rotation or any similar problem until the personal errors of measurement of each observer have been determined. He gives the formula which represents the values of the solar rotation for 1913.

"L'ASTRONOMIE" FOR SEPTEMBER AND OCTOBER, 1914.—It is satisfactory to be able to state that in spite of the difficulties encountered at Paris in August and the following months of last year, the Bulletin of the French Astronomical Society, *L'Astronomie*, has not broken its continuity. The September and October numbers are now to hand, and those of November and December are completed, and will soon be issued. The September number continues the interesting series of articles on visits to the European observatories, that to the Zurich Observatory being here described and illustrated. Under the title "Jupiter" the observations made on that planet during the opposition of 1913 are described in some detail. Interesting curves are included, showing the displacement of the large red spot in longitude for a period of six months, and the variations of the duration of its rotation for the period 1830–1913. The chief contribution to the October number is a series of accounts of observations of the eclipse of the sun in August last, made from and outside of the line of totality. Some of these, notably that by the expedition from the Meudon Observatory, have already been referred to in these columns.

THE CANADIAN ASTRONOMICAL HANDBOOK.—"The Observer's Handbook for 1915," published by the Royal Astronomical Society of Canada, and edited by Dr. C. A. Chant, is in the seventh year of publication. The present issue is conspicuous by the absence of the brief review of astronomical progress, but this is probably more than neutralised by the addition of useful tables of double and variable stars, and an interesting table, compiled by Mr. W. E. Harper, giving some concise information regarding the brighter stars. The last-mentioned deals with 272 stars and five nebulæ, and gives the chief known facts concerning their distances, spectral types, proper motions, radial velocities, etc. In the section on the constellations charts are given containing the stars down to the fifth magnitude. Mr. W. F. Denning contributes the section devoted to meteors and shooting stars. The other sections are mainly on the lines of former issues.

COPPER SMELTING IN CANADA.

THE Canadian Department of Mines has issued an interesting report of some 184 pages, profusely illustrated, upon the copper smelting industries of Canada, from the pen of Dr. Alfred W. J. Wilson, Chief of the Metal Mines Division. This report forms a valuable record of the position of Canada as a copper producer at the date at which it was written, namely, the close of the year 1912. As the author very truly observes, "the period of time which necessarily elapses between the writing and the publication and distribution of Government reports is usually too long to make them an important medium for the distribution of new knowledge in an old and well-established industry," and indeed the present report well exemplifies the correctness of this view, there being nothing in it with which copper smelters throughout the world are not thoroughly familiar, its chief value lying accordingly in the fact that it furnishes a trustworthy "record of the status of the industry at the time it was prepared," which Dr. Wilson puts forward as the chief purpose for which it was written.

The work contains an introductory chapter, separate chapters dealing in detail with the works of the Canadian Copper Company, the Mond Nickel Company, Ltd., the Consolidated Mining and Smelting Company of Canada, Ltd., the Granby Consolidated Mining, Smelting, and Power Company, the British Columbia Copper Company, and the Tyee Copper Company, and final chapters of summaries and statistics. From these it appears that at the date mentioned there were in operation in Canada in the seven smelting works of the above six companies twenty-nine large rectangular water-jacket blast furnaces, with a total hearth area of 2580 sq. ft., and a rated capacity of 15,600 tons of charge per twenty-four hours; the largest of these is a 50 in. by 420 in. furnace of the Consolidated Mining and Smelting Company, with a rated capacity of 875 tons of charge per twenty-four hours, but there are no fewer than four of these furnaces with a smelting capacity of 700 tons or more per twenty-four hours, and only two with a capacity below 400 tons. The matte produced in these blast furnaces is blown in converter plants, of which there are five in all, two being operated by the Granby Consolidated Mining, Smelting, and Power Company, at their Grand Forks and Anyox Works respectively, and one each by the Canadian Copper, the Mond Nickel, and the British Colombia Companies. All but the last-named are basic lined, some using the horizontal cylindrical and some the vertical patterns.

The Canadian Copper Company produces a furnace matte with about 28 per cent. of copper-nickel, which is blown in the converters to rich matte, with 80 per cent. of copper-nickel; the Mond Nickel Company runs a furnace matte with 33 per cent. of copper-nickel, which is also blown up to 80 per cent. (38 per cent. copper, 42 per cent. nickel, 15 per cent. iron); these rich mattes are shipped for further treatment and refining. The Granby Consolidated Company was only operating the works at Grand Forks in 1912, the Anyox works not having been started as yet; they were producing furnace matte with 35 per cent. of copper, which was blown up to blister copper of good quality with 99·5 per cent. of copper, containing, in addition, gold and silver; the British Columbia Company smelted a furnace matte with 40 per cent. of copper, which was also blown up to blister copper. Both these companies shipped their blister copper to the United States for refining.

As to the two companies that do not operate converters, namely, the Consolidated Mining and Smelting Company at Trail, and the Tyee Company, the former runs a first furnace matte with 10 per cent. of copper, which is twice concentrated in the furnaces, the second matte containing 15 to 20 per cent. of copper, and the final matte 40 to 42 per cent. of copper; the Tyee Company runs largely on customs ores, and produces a final matte with 40 to 43 per cent. of copper; both these companies ship their mattes to the United States for further treatment. It thus appears that although Canada produced in the above year nearly 78 million pounds of copper, not one pound of this was converted into merchantable copper within the Dominion. The only reference to this fact to be found in the report before us is an incidental statement by Dr. Wilson that "there are no copper refineries in Canada." It is difficult to understand why Canadian copper producers should be willing to forgo the very handsome profit realised by the refining of their crude products, and why they should be so ready to ship these products to the United States instead of completing the refining process at home.

Dr. Wilson avows as one of the objects of this report that "it may possibly be found useful to parties who are contemplating investments in the development of similar industries in other sections of the country," but it is surely of far greater importance to Canada that it should be in a position to utilise fully its mineral production, and to put it on the market as material ready for use in the arts, and not in an only partly manufactured condition. Surely one of the many economic lessons enforced by the present war is the need for the Empire to be as nearly as possible self-supporting, so that we may be, as far as practicable, independent of other nations for the supplies that we chiefly need. This is not always possible, because even the vast British Empire does not furnish all the natural products that we use, but in the copper smelting industry of Canada we have an example where we are deliberately giving away our natural advantages. Seeing that this is a case where both patriotic motives and commercial interests point in the same direction, it may fairly be hoped that there will be found in Canada men enterprising enough to finish what they have begun, and that the reproach that the Dominion is unable to refine its own copper production will soon be removed. This is certainly not the conclusion that Dr. Wilson has drawn, nor perhaps the one which he wishes to be drawn from his careful and comprehensive report, but it certainly is the main impression that the reader of his report is likely to carry away from its perusal. H. L.

AGRICULTURAL AND HORTICULTURAL RESEARCH.[1]

THE varied research activities manifest at Woburn are reflected in the contents of the fourteenth report. They include experiments in potato spraying, trenching, the distribution of soil particles, the effect of one crop on another, the control of the black currant mite, and the loss of manure in transit. It is not possible within the limits of a short notice to discuss all these subjects, nor perhaps is it necessary. For as is inevitable with interim reports, final results may not be expected. Thus with respect to the experiments in potato spraying with Bordeaux mixture and with Woburn paste, the report, though it advances our knowledge another stage, does not make final revelation of the secret of the prophylactic virtue of copper sulphate against late blight (*Phytophthora infestans*). Mr. Pickering recognises that the problem is complex, and inclines to the view that the spray fluid acts rather by inducing healthier foliage than by destroying the spores of the fungus (p. 30). Although on the scientific side of the question much remains obscure, Mr. Pickering records notable progress on the commercially practical side. He finds that Woburn paste used at the rate of 15 or 16 lb. is equivalent in its effect to Bordeaux mixture made from 8 lb. copper sulphate, and this although the paste contains five or six times less copper than does the mixture.

If we may offer a suggestion it is that Woburn should undertake a series of records spread over a term of years with the view of settling a question which vexes the minds of not a few of our best and biggest growers—whether in the *long run* spraying with Bordeaux mixture is or is not profitable. Those who know only the laboratory side of the subject may scoff at the question, but Mr. Pickering's experience would doubtless confirm the reviewer's, that many hard-headed lowland Scots do not spray, and give as their reason that it does not pay. Evidence from America, where large-scale spraying experiments have been carried out, would appear to put the men in the wrong, but in spite of that and similar evidence in this country, these men maintain their negative position. If, as Mr. Pickering estimates, the benefit of spraying in a year of blight is only about 10–30 per cent., and if, as is well known, spraying to be of much use must be begun before the disease appears, the unconverted grower may have economic justification for his heresy.

Mr. Pickering's experiments in bastard trenching, carried out in conjunction with Dr. E. J. Russell, lead to negative results which are at first sight surprising. For it might be supposed, from what is known of the need of roots for air, that the mere disturbance of the soil would benefit the crop. It has to be borne in mind, however, that the experiment was carried out with fruit trees, and it is at least probable that when the trees were planted the soil in which they were planted was disturbed sufficiently for their needs. Mr. Pickering is right in believing that where a hard pan exists not far below the surface, bastard trenching even without the addition of manure is of value.

When so much is done at Woburn it is almost ungracious to ask for more, but we should like very much to see the effect of the bastard trenching on a crop of vegetables—carrots or beet, for example. It is rash to prophesy in horticulture, but we incline to the belief that the effect, though perhaps not great, would be positive and not negative, as in the case of the fruit trees.

The Annual Report (1913) of the Agricultural and Horticultural Research Station at Long Ashton, Bristol, shows that this comparatively young institution is carrying out a large amount of useful work.

As is natural, much of the report is concerned with problems connected with cider and perry-making. A subject of wider interest is that of the influence of the stock upon vintage quality and other characters of apples. Growers as a class are apt to maintain that the stock exercises a considerable though ill-defined influence on the scion, and there is a good deal of scattered information on the subject. The analyses of fruit juices published in the report indicate that the nature of the stock is without influence on the quality of the juice of the fruit; save that the rates of fermentation of juices obtained from fruit grown on the Paradise stock are in most cases higher than those from fruit grown in the free stock.

For our part we are inclined to believe that light would be thrown on the subject by an investigation of the oxydases of scion and stock; for it is by no means improbable that research will discover that these potent agents may pass along the wood and bast, and thus affect the rate of chemical change in far-distant tissues.

The influence of grass on the growth of orchard trees—a subject brought into prominence by Mr. Spencer Pickering's observations—is discussed by Mr. Barker on the basis of experiments carried out at Long Ashton and in several demonstration orchards in the west of England.

Mr. Barker, beside confirming the view that grass exercises a depressing influence on tree growth makes the new point that trees grown in land which is first cultivated and subsequently grassed are apt to be outdistanced in growth by those which are grown in grass from the start of the experiment. Mr. Barker suggests that this may be due to the trees previously free from the grass feeling the ill-effects of grassing all the more acutely because of their former immunity from those effects. The phenomenon does not appear to conform with current opinion, which holds that, once they are well-established, trees do not suffer from growing in grass.

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[1] (1) Fourteenth Report of the Woburn Experimental Fruit Farm. By the Duke of Bedford and Spencer U. Pickering. (London: Amalgamated Press, Ltd., 1914.) Price 2s. 9d. post free.

(2) University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station. (The National Fruit and Cider Institute). Long Ashton, Bristol, 1913. Pp. 110. (Bath: *Herald* Press, n d.)

PARIS ACADEMY OF SCIENCES.

PRIZES PROPOSED FOR THE YEAR 1916.

Geometry.—The Francœur prize (1000 francs), to the author of discoveries or works useful to the progress of pure or applied mathematics; Grand prize of the mathematical sciences (3000 francs), subject proposed, to apply the methods of Henri Poincaré to the integration of some linear differential equations, algebraic, and chosen from the simplest examples; the Poncelet prize (2000 francs), for work in pure mathematics.

Mechanics.—A Montyon prize (700 francs), for invention or improvement of instruments useful to the progress of agriculture, the mechanical arts or sciences; the Henri de Parville prize (1500 francs) for original work in mechanics; the Fourneyron prize (1000 francs), to the author of the most important improvements in aviation motors.

Astronomy.—The Lalande prize (540 francs), to anyone, in France or elsewhere, who has published the most interesting observation, memoir, or work useful to the progress of astronomy; the Valz prize (460 francs), to the author of the most interesting astronomical observation made in the course of the year; the Janssen prize, for an important progress in physical astronomy.

Geography.—The Tchihatchef prize (3000 francs), for the recompense or encouragement of naturalists of any nationality distinguished in the exploration of the lesser-known regions of Asia; the Gay prize (1500 francs), for improvements in instruments or methods of topometrical and topographical surveys; the Binoux prize (2000 francs), for work in geography or navigation; the Delalande-Guérineau prize (1000 francs), to the Frenchman who, as traveller or *savant*, shall have rendered the greatest service to France or to science.

Navigation.—The extraordinary prize of 6000 francs for work increasing the efficiency of the French naval forces; the Plumey prize (4000 francs), for an improvement in steam engines or other invention contributing to the progress of steam navigation.

Physics.—The Hebert prize (1000 francs), for a treatise or discovery valuable for the popularisation and practical use of electricity; the Hughes prize (2500 francs), for a discovery or work contributing to the progress of physics; the La Caze prize (10,000 francs), to the author, French or foreign, of works or memoirs contributing to the progress of physics; the Kastner-Boursault prize (2000 francs), for the best work on the various applications of electricity in the arts, industry, and commerce.

Chemistry.—The Jecker prize (10,000 francs), for work in organic chemistry; the Cahours prize (3000 francs), for the encouragement of young workers already known for researches in chemistry; the Montyon (unhealthy occupations) prize of 2500 francs, and mention of 1500 francs, for the discovery of a means of reducing the unhealthiness of a trade or calling; the Houzeau prize (700 francs), for a young deserving chemist; the L. La Caze prize (10,000 francs), to the author, of any nationality, of the best work on chemistry.

Mineralogy and Geology.—The Victor Raulin prize (1500 francs), for facilitating the publication of works relating to geology and palæontology.

Botany.—The Desmazières prize (1600 francs), for the best publication during the year on Crytogams; the Montagne prize (1500 francs), for work on the anatomy, physiology, development, or description of the lower Cryptogams; the Da Coincy prize (900 francs), for work on phanerogams; the de la Fons-Mélicocq prize (900 francs), for the best botanical work on the north of France.

Anatomy and Zoology.—The Savigny prize (1500 francs), for the assistance of young travelling zoologists, not receiving a Government grant, and who study specially the invertebrates of Egypt and Syria; the Cuvier prize (1500 francs), for a work on zoological palæontology, comparative anatomy, or zoology; the Thore prize (200 francs), for the best work on the habits and anatomy of a species of European insects.

Medicine and Surgery.—The Montyon prize (prize of 2500 francs, mentions of 1500 francs), for works or discoveries judged most useful to the art of healing; the Barbier prize (2000 francs), for the author of a valuable discovery in the surgical, medical, or pharmaceutical sciences or in botany having relation to medical science; the Bréant prize (100,000 francs), for the discovery of a means of curing Asiatic cholera or discovering the causes of this disease. Failing the award of the prize, the interest on the capital sum will be awarded for advances in connection with cholera or any other epidemic disease; the Godard prize (1000 francs), for the best memoir on the anatomy, physiology, and pathology of the genito-urinary organs; the Baron Larrey prize (750 francs), to a doctor or surgeon in the army or navy, for the best work presented to the academy and dealing with medicine, surgery, or military hygiene; the Bellion prize (1400 francs), for work or discoveries profitable to the health of man or to the amelioration of the human species; the Mège prize (10,000 francs), to an author who should continue and complete his essay on the causes which have favoured or retarded the progress of medicine from antiquity to the present day. The interest on this sum can be awarded by the academy as they see fit.

Physiology.—The Montyon prize (750 francs), for a work on experimental physiology; the Philipeaux prize (900 francs), for works in experimental physiology; the Lallemand prize (1800 francs), for work relating to the nervous system in the widest sense of the words; the Pourat prize (1000 francs), for a memoir on the cell constituents which exert the main influence on the water content of the different tissues; the La Caze prize (10,000 francs), to the author, French or foreign, offering the best work on physiology; the Martin-Damourette prize (1400 francs), for a work on therapeutical physiology.

Statistics.—The Montyon prize (prize of 1000 francs, and two mentions of 500 francs). The academy will consider not only memoirs sent in manuscript, but also works already printed and published which are brought to their knowledge.

History of Sciences.—The Binoux prize (2000 francs).

General Prizes.—The Arago medal; the Lavoisier medal, for eminent services to chemistry without distinction of nationality; the Berthelot medal, to persons who have been awarded by the academy prizes in chemistry; the Henri Becquerel prize (3000 francs); the Gegner prize (3800 francs); the Lannelongue prize

(2000 francs), for the relief of unfortunate scientific men or their immediate relations; the Gustave Roux prize (1000 francs), for a young French scientific worker; the Trémont prize (1100 francs); the Wilde prize (one prize of 4000 francs and two of 2000 francs), awarded without distinction of nationality for work in astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics; the Lonchampt prize (4000 francs), for the best memoir on work on the diseases of man, animals, or plants from the special point of view of the introduction of mineral substances in excess as the cause of these diseases; the Saintour prize (3000 francs), for work in the physical sciences; the Henri de Parville prize (2500 francs) for original scientific work or publication; the Victor Raulin prize (1500 francs), for assisting the publication of work relating to geology and palæontology; the Houllevigue prize (5000 francs); the Caméré prize (4000 francs), to a French engineer for improvements in the art of construction; the Jérome Ponti prize (3500 francs); the Bordin prize (3000 francs), the subject proposed for 1916, researches relating to the determinism of sex in animals; the Parkin prize (3400 francs), for researches on the curative effects of carbon in various forms, and more especially in gaseous form of carbon dioxide, in cholera, the different forms of fever or other diseases, or, as an alternative subject, for researches on the effects of volcanic action in the production of epidemic diseases in the animal and vegetable kingdoms and in causing abnormal atmospheric disturbances; the Jean Reynaud prize (10,000 francs); the Baron de Jouest prize (2000 francs), for a discovery useful to the public welfare; the prize founded by Mme. la Marquise de Laplace (a complete collection of the works of Laplace) to the first student leaving the Ecole Polytechnique; the Felix Rivot prize (2500 francs), divided between the four students leaving each year the Ecole Polytechnique with the first and second places in the section of Mines and of Ponts et Chaussées.

THE ENGLISH CERAMIC SOCIETY.[1]

THE English Ceramic Society, to judge from the latest issue of its Transactions, still continues to do excellent work. Although the present number contains no article of first-rate importance, it is obvious from the general character of the communications, and the nature of the discussions by which they are followed, that the members are fully alive to the value of the society in promoting exchange of experience and opinion on the many obscure problems with which the art and craft of the potter is beset. No indication of the health and vigour of the society could be more significant than the manner in which individual knowledge and experience are made to contribute to the general benefit of the industry. Such a spirit has been far from the rule in times past, for in no other industry have trade secrets and little details of practice been more jealously guarded than in potting. The enlightened example of the society will do much to break down this absurd exclusiveness and short-sighted selfishness. If each thus contributes to the common stock, the general welfare is increased, and the position of the industry as a whole is enhanced, to the collective benefit of the manufacturers and the country generally. In this respect we have something to learn from our enemies. The spirit of co-operation has largely contributed to raise manufacturing in Germany to the formidable position it has gained. If we are to maintain, and especially if we are to increase our pre-eminence as the largest traders in the world, this spirit of co-operation and mutual helpfulness must continue to prevail, and to grow.

The communications in the present issue of the Transactions call for no special comment. The "Symposium on Fineness of Grinding" brought out a considerable difference of opinion as to the relative merits of cylinder- and pan-grinding, and as to the influence of the fineness of the particle on plasticity, contraction, texture, porosity, and "crazing"—all of them points which are capable of a satisfactory solution if attacked experimentally in a scientific manner. These are typical of the kind of problems with which the County Pottery Laboratory at Stoke-on-Trent may be expected to concern itself. The discussion on grinding bore unmistakable testimony to the influence of the human element, especially in pan-grinding. That influence was no less marked in the course of the discussion on "firing," and of the relative importance of "tops" and "bottoms," where opinion was equally divided. The average "fireman" may be (and evidently is in the opinion of some) a rather perverse and obstinately conservative kind of individual, wholly wedded to traditional practice, but if this volume falls into his hands, he may at least be able to retort that he knows more about firing than his betters seemed to know about French on the occasion of their visit to the pot-banks of our Ally! *Verb sap.* T.

EDUCATION IN RELATION TO INDUSTRY AND COMMERCE.[2]

Our First Purpose.

WE are now in the midst of the greatest struggle that the British Empire has ever been engaged in. The outcome of the struggle involves not only our existence as a nation, but the existence of those principles and ideals of life and government which we hold dear. Our energies, individual and national, must for the moment all be turned to one purpose, to bring the war to a successful conclusion. The men who are fighting at the front are doing magnificent work, but it is for each of us in his own sphere to do his share in order that at the earliest possible moment the world may be free from the terrors of the war.

In time, peace will come. With that peace there will be renewed the international struggle for trade, and British enterprise must be ready to take full advantage of the great opportunities that will then occur. Individual effort will not be of any great use. Concerted action is essential if we are to retain the foremost place in the world of trade; and just as we are vigorous in the pursuit of the present war, so as a nation must we be vigorous in the pursuit of industrial and commercial supremacy.

The Industrial Army.

How is this supremacy to be attained? It is primarily a question of education. We must have in the first instance an industrial army, capable, alert, and well trained. The production of this army must begin in the elementary schools. The leaving age of school children, for urban districts at least, must be raised to fourteen years, and age must be made the only leaving qualification. Moreover, the children should leave at the end of the educational year in which they reach the leaving age, or, at any rate, they should leave only at the end of the school term in which the leaving age is reached. For this reform we must look to Parliament, as it is impossible for a local authority to make the change in view of the many local interests involved.

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[1] "Transactions of the English Ceramic Society," Vol. xiii, Session 1913–14. (Stoke-on-Trent: Hughes and Harber, Ltd., 1914). Price to non-members, 30s.

[2] Address delivered before the National Association of Education Officers on January 1 by the president, Mr. James Graham.

With the leaving age at fourteen years, local authorities and teachers, after making a careful selection of the boys and girls who should go forward to a secondary school at the age of twelve, could turn their attention to the children left in the elementary schools, who as a body may be expected to receive very little general education beyond that obtained in the elementary schools. For these children it would be possible to organise special two-year courses which should prove extremely valuable in preparing them for the work they will undertake on leaving school.

Preparation in the Elementary Schools.

A large proportion of the boys from our elementary schools enter some trade or some branch of industry, and for these the courses of study between the age of twelve and fourteen years of age, while remaining on broad general lines, should be somewhat industrial in character. There is at the present time a strong demand for industrial or vocational education in which practical methods and manual training are involved, but it must not be forgotten that the purpose of elementary education is not to prepare for a particular trade, but rather to develop all the child's faculties so that he may be prepared to enter any walk of life. The all-round general education of the child must be the first consideration, and in the suggested courses of study no attempt should be made to teach any specific trade. The courses would be entirely preparatory and general-trades work, and would involve teaching the theory and principles which underlie British trades generally. "Learning by doing" would take the place of "book learning." An attempt would be made to put the whole boy to school, to train the entire faculties of the boy, intellectually, morally, and physically, and so fit him for life. The work which is now generally done in artisan evening schools would be covered by every boy in an urban elementary school, where the work would be done under vastly better conditions, as the teaching would be given to boys who are fresh and vigorous instead of to tired boys who have already done a day's work.

The workshops of the country require boys with self-effort, self-reliance, initiative, and thought, and it should be the object of these courses to provide just that training which would develop these habits. The general adoption of this development in elementary education would create in the near future a supply of intelligent boys, who would rapidly become in the workshops intelligent and skilled workers, ready and able to adapt themselves to the changing working conditions of the trade and of the times; and we should hear no more of the employers' complaint that the present product of the elementary schools is not the type of youth they require in their shops.

In the proposed courses, roughly one-third of the school time of the boy during the age of twelve to fourteen should be devoted to the study of English subjects, one-third to mathematics and technical drawing, and the other third to actual experiments and practical work in the laboratory or workshop. The scheme of instruction would be arranged with the intention of securing an all-round development of the boy's faculties in a thoroughly practical manner, in order that by the time the boy is ready to commence work he may possess not only a general grip of the principles which underlie trades in general, but such intelligence, reasoning power, and adaptability as are calculated to secure for him the approval and good will of his employer.

This preparatory practical training before the boys enter the workshop or factory is the first step in the production of a capable industrial army. I reiterate that at this stage the practical training must be general; there must be no attempt to teach any specific trade, but every effort must be made by curriculum and by method to develop all the faculties of the boy.

Education of Boys in the Workshops and Factories.

We now come to the second age period and deal with the problem of the boys from fourteen to eighteen years of age. The boys have now left the school. They are in the workshops, and specific trade instruction must begin. Opportunities must be provided for the boy to lay the foundation of a livelihood which in the main will persist through life. At the same time it must not be forgotten that the boy is something beyond a potential wage-earner or producer. He is a future citizen, and in the scheme of education for such youths time and opportunity must be provided not only to enable him to understand the occupation which he has entered and from which he is to obtain his livelihood, but also to enable him to understand his duties as a citizen. There should be provided opportunities for mental, physical, and moral training which shall fit him for manhood and for his place in the nation.

The Teaching of Trades.

The modern workshops are highly organised and specialised with a view to enable employers to reduce the cost of production and to compete successfully for orders; consequently it is practically impossible to-day for an English boy to learn the whole of a trade in a workshop. It is in this connection that the technical schools of the country working in close cooperation with the workshops should fulfil their real function. When the boy enters the workshop his education is far from complete, even if he has had the general practical training outlined above. Continued education applicable to his chosen trade must be given, and the problem that confronts us is how best to ensure that the boy shall have this technical education in spite of the fact that the industrial conditions are vastly different from what they were.

In the old days the employer was the sole educator of his apprentice or young worker. Under present conditions it is impossible for the employer to give the young worker all the instruction he requires. The schoolmaster, therefore, has been called in to undertake part of the work. Under this divided responsibility, the work of the teacher is to give the young worker a thorough grasp of theoretical principles and to provide him with such knowledge and training as will enable him to adapt himself to changed conditions, to attack new problems, and to show initiative and skill in his work. The duty of the employer, on the other hand, is to give that advice and assistance to the teacher as will ensure that the work of the school shall not be merely academic but essentially practical, and to supplement the instruction by doing all that is possible to give the young worker ample opportunities for getting an all-round experience of his trade.

At the present time the young worker is expected to get the necessary technical education by attending the school for three or more evenings a week after he has done a full day's work in the workshop or in the factory. It is quite unnecessary to point out the drawbacks and disadvantages of this system. Excellent work has been done in the evening schools by youths of grit and character, who have attended them, and a number of employers have done a good deal by means of suitable inducements to encourage their young workers to take full advantage of the opportunities for gaining increased knowledge and experience—but voluntary attendance at evening schools and voluntary schemes of co-operation between employers and educational authorities do not really touch the huge problem. The only effective way to train the rising generation of skilled workmen after leaving the elementary schools is to have half-time in the workshop and half-time at the technical school between the ages of fourteen and eighteen. In the words of our friend, Mr. J. H. Reynolds, the solution of the problem is "Half-time at the right time." Good health and physique are as necessary to the skilled workman as is the technical knowledge applicable to his trade, and the youth should have the opportunity of obtaining this technical knowledge without detriment to his health. In other words, he should be allowed to attend suitable courses of instruction for periods of suitable length within the normal working day.

Half-time in the workshop and half-time at the technical school is certainly ideal, but possibly at present it is not practicable. At least some modification of this arrangement must be adopted to enable young workers to attend day courses on three or four half-days a week, and thus get the necessary continued education during the daytime. Only a small proportion of the young workers of the country attend evening schools in spite of all the inducements offered and all the encouragement given, and no one would assert that they derive the greatest benefit from their attendance. The result would be infinitely better if the youth spent sixteen to twenty hours a week during the daytime at the technical school and the remainder of his time at the works.

If England is to maintain her place in the world as an industrial and commercial nation, she will have to adopt this method of teaching trades to her boys. Other nations are doing a great deal in this direction. We must do more than they because we have more at stake, and we must act promptly and boldly. Legislation is necessary; it must be made the duty of the employer to allow to the employee the time required for continuing his education according to the requirements of the trade or business which the boy enters. The need for a further limitation of juvenile labour is urgent, and it is equally necessary to place employers of labour under statutory obligation to enable young persons under eighteen years of age who are in their employment to attend courses of technical and general instruction at certain hours of the daytime when they are not too tired bodily and mentally to profit from the instruction. An Act of Parliament limiting the hours of employment for all young persons under eighteen and placing that limit so low that there shall be ample time during the normal working day for attendance of the young people at suitable courses of instruction is required.

The Leaders of Industry.

An army requires capable leaders, and there must be in connection with the training of an industrial army opportunities for the selected few to become successful leaders of industry. For these no education can be considered too good. A thorough training in the secondary schools and the universities, combined with adequate experience in a workshop or factory, is necessary. Science now plays so important a part in industry that more vigorous efforts than hitherto must be made to secure the highest and most suitable education and training for capable youths, and the future leaders of industry in England must be induced to equip themselves for competition on equal terms with the more highly trained young men of other nationalities.

The value of a thorough general education in the secondary school and university cannot be overstated, and full technical knowledge of the particular industry is equally necessary. The training of the young men must be practical as well as theoretical; actual experience in the workshop or factory is as important as the scientific training at the technical college or university, and service in a recognised office, workshop, or factory must be compulsory for a period either before or after the college course, or during the continuance of the college course. The period of training for the men who are to fill the higher posts in industry should be at least for a period of six or eight years, in order that the student may have time to develop his powers of thought and to obtain a complete knowledge of the theory and principles underlying the industry, together with a first-hand knowledge of the processes of the industry obtained by actual contact with it in the workshop or factory.

Some of the highest posts in industry will be filled by men who, in the first instance, enter the works as youths, and who on account of their unusual capacity force their way through the various grades to fill positions of responsibility. It is of the greatest importance that opportunity should be provided for youths of proved ability to secure the education and training required of those who fill the highest positions in industry if for financial reasons their parents are unable to provide that training. In this connection a duty falls upon the local education authority to make special provision for the benefit of such youths. Scholarships must be provided to enable young workers of proved ability to attend day courses at the technical college or university for three or four years in order that they may obtain a professional training that will prepare them to fill posts of greater responsibility in the future.

In the past, England has had too few specially trained leaders of industry. To organise industry, men, shrewd, enterprising, and with full knowledge regarding the application of scientific methods in the development of industry are required. For these men there must be a most comprehensive and thorough education and training on the solid foundation of a good general education. They must have a sound knowledge of the mutual relation of science and industry and an intimate knowledge of their particular industry in order that all problems may be attacked systematically and on a scientific basis. Men of practical capacity and trained thinkers, endowed with the power of applying their knowledge to the practical necessities of industrial processes are essential in the industrial army, and the absence of a comprehensive scheme for the training of such men must prejudice the future of our country.

Commercial Army Necessary.

It is not sufficient to have a well-equipped industrial army; there must be markets for the products of industry. The goods produced must be sold, and we must have, therefore, a commercial army as well trained and equipped for the work of distribution as the industrial army is for the work of production.

It has often been stated that England is deficient in what is usually called technical education, but we must frankly acknowledge that she is infinitely worse off in regard to commercial education in spite of the development of this type of education during recent years.

The United Kingdom still ranks first among the commercial countries of the world, with its enormous annual imports and exports, its immense home trade, and its great shipping trade. We not only carry the whole of our own commodities, but we do an enormous amount of carrying for other countries. In view of these facts it is strange that commercial education should have been so strangely neglected in England. Travellers, agents, and consuls representing the interests of British trade abroad are generally foreigners who have been thoroughly trained in the practice and theory of business while at home. The majority of our foreign correspondents and managers of firms with branches abroad are likewise foreigners. For years we have been giving the foreigners a practical experience and knowledge of our manufactures and methods of business which qualify them to meet us as strong competitors. These foreigners come in large numbers; they very often enter our business houses with a view of acquiring information as to the inner working of the firm's business connections, and on going back to their own country they join a rival establishment or set up an establishment of their own.

English firms are driven to the employment of foreigners because young men in England do not pay sufficient attention to commercial education and to the study of foreign languages.

The Training of a Commercial Army.

This state of affairs cannot be allowed to continue. We must produce an army of trained traders, and in the production of this army education must play a prominent part.

The first essential for one who is to enter a commercial career is a sound general education in which the study of English and at least one foreign modern language should be of first importance. Any intending business man should have a secondary-school education and specialised commercial study should not be commenced until the age of fifteen at least. In many good secondary schools commercial sides are organised for the higher forms, and the studies of the pupils are given a certain amount of commercial bias.

The commercial education so given is strikingly inadequate in comparison with the provision in other countries. Unfortunately we in England still retain the idea that a small amount of education is sufficient for a man destined to be a trader, whereas other countries are more enlightened, and they endeavour to provide for the future trader the highest education applicable to his walk in life.

Schools for Commercial Education.

England in this matter has delayed far too long. It is now essential that there should be established in this country schools of commerce which in our English system might well form one side of our secondary schools, with a curriculum specially designed for the higher education of young people who are destined for a business career. The teaching staff must be really competent, and the school must be equipped for teaching the theory of business, and as much of the practice of business as possible, the general aim of the school being to train well-equipped employees of all grades from the competent clerk to the competent employer.

A Typical School of Commerce.

Belgium was the first nation to give practical effect to the idea of establishing a special college for the commercial training of her young men. The aim of the exhibition held at the Crystal Palace in 1851 was to compare the progress made by the different peoples in the development of the industrial arts. It was recognised that England held the first place. But while we rested complacently on our oars, other nations profited by the lesson and began to take steps to promote their home and foreign trade. Belgium recognised that competent men to represent her in the foreign markets were required, and as a result the Higher Commercial Institute at Antwerp came into existence. It was to be to the men destined for a commercial career what the university was to the doctor or the lawyer. Similar institutions have since been founded in France, Switzerland, Germany, Austria, Italy, and even in distant Japan. Before admission candidates must show competent knowledge as tested by an entrance examination. The curriculum embraces the study of all subjects, a knowledge of which is indispensable to the merchant, the banker, or the trader, including at least two foreign languages, book-keeping, commercial documents, geography, history, arithmetic, and algebra, commercial law, and the elements of political economy, as well as physics and chemistry. The course of study is practical as well as theoretical. Transactions of a large commercial house are simulated, the operations of a counting-house are minutely practised and all questions relating to the theory of exchanges are carefully described. Correspondence is conducted by the student in French, German, and English. The principles of international commercial law and customs' legislation are inculcated, and special care is taken to make the student acquainted with foreign markets by furnishing him with reports sent in periodically by Belgians resident abroad. To further the knowledge of all kinds of vegetable, mineral and animal products, there is a well-furnished museum with samples and patterns kept up to date, so that the professor is able to give to his pupils a direct knowledge of the article, in which the latter may one day be called upon to trade. The actual political and economical condition of foreign countries is studied from carefully compiled data and the relative value of raw material from different sources of supply is inquired into and noted. The student is encouraged to take a close interest in the political events of to-day so far as they affect commercial interests, and the latest consular reports from all countries are placed at his disposal, so that he himself later on may be in a position to make a report upon the commercial practice of any country in which he may happen to find himself. Visits to factories, mills, mines, etc., enable the student to acquire an insight into the actual working of those industrial establishments.

Valuable travelling scholarships are given to the best students, who are thus relieved of the necessity of accepting the first situation that is offered to him. He is enabled, in fact, to study the economical condition of the country in which he resides, but he must send home periodically a detailed report of the result of his observations. These reports, after being noted by the Government, are utilised by the students in the prosecution of their studies.

The Training of Clerks.

For those engaged in business who are not able to attend full time at a day school of commerce, arrangements should be made by which they should be able to attend such schools on three or four half-days a week during the normal working hours. The young worker in a house of business is in the same difficulty as the young industrial worker: he cannot get an all-round training; and at present he must get his theoretical knowledge of commerce by attendance at a commercial evening school on three evenings a week. This system is unsatisfactory; but by a part-time attendance at a day school of commerce, he might go through a modified course of instruction which combined with his experience in a business house should make him far better fitted for the post he is filling.

Training for the Consular Service.

In the school for commerce the highest courses are arranged for the special purpose of fitting the student for the Consular Service. At the present time England is generally represented abroad by a foreigner whose first interests naturally are not British. What we require is that every Consul representing British interests should be an Englishman specially trained for the service, with a full knowledge of British trade, and ready and able to place British interests first.

A Liberal Education Necessary.

Our travellers, managers, agents, and responsible clerks in connection with all branches of industry should be properly trained. They should complete a course of study applicable to their particular calling, including modern languages for commercial purposes, commercial arithmetic, book-keeping and accounts, commercial practice, geography and history of commerce, economics and commercial law. At the same time it cannot be too strongly urged that opportunities must be provided for education apart from the purely utilitarian form.

The period between fourteen and eighteen years of age is a vital period during which the youth should have the opportunity of fitting himself for livelihood and for life. He should have the opportunity of learning in the fullest sense his trade or business and of developing those faculties of mind, body, and spirit that would enable him to fulfil his duties to his neighbours and to the nation. The school course should, therefore, offer beyond the purely technical or commercial subjects other subjects of a liberal character. The youth is not merely a wage-earning industrial or commercial; he is a human being, and his education and training should enable him to occupy his leisure time to good advantage.

Responsibility of Education Officials.

A responsibility rests upon us as education officials. It is for us to see that the educational needs of the nation are really appreciated, and that the fullest educational opportunities are provided for all. If we rightly do our part there should arise in England an industrial army and a commercial army capable of maintaining for our country that industrial and commercial supremacy which is vital to a nation so situated as we are.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The *Cambridge Review* has just published the names of the past and present members of the university who are serving in some capacity in the King's Forces. The number amounts to 7,237, and they are distributed amongst the colleges as follows:—Trinity College, 1,840; Pembroke, 760; Gonville and Caius, 616; Clare, 535; King's, 436; Jesus, 385; Emmanuel, 371; Christ's, 359; St. John's, 337; Trinity Hall, 328; Magdalene, 214; Queen's, 179; Sidney Sussex, 154; Peterhouse, 140; Downing, 126; Selwyn, 125; St. Catherine's, 117; Corpus Christi, 109; Fitzwilliam Hall, 90; Honorary Graduates, 16. With one or two exceptions the numbers run parallel with the sizes of the colleges in normal times, and the list is, with these exceptions, in much the same order as the colleges would be classified if they were arranged on a basis of the number of students.

The General Board of Studies has appointed Mr. K. J. J. Mackenzie, of Christ's College, Reader in Agriculture.

LONDON.—Two appointments to the university professorships were made by the Senate on January 27. Dr. Edward Barclay-Smith, of Cambridge, succeeds Prof. Waterston in the Chair of Anatomy at King's College, and Dr. E. P. Cathcart, of Glasgow, succeeds Prof. Leonard Hill in the Chair of Physiology at London Hospital Medical College.

The D.Sc. Degree has been granted to the following:—Mr. E. L. Kennaway, Guy's Hospital, for physiological chemistry; Miss Ethel N. Thomas, University College, for botany; Mr. J. Kenner, East London College, for chemistry; and Mr. J. Kenyon, external student, for chemistry.

The Hon. R. C. Parsons succeeds Prof. Cormack as one of the representatives of the university on the governing body of the Imperial College of Science and Technology.

MANCHESTER.—At a meeting of the Court of the University held on January 27 Sir Henry Miers, F.R.S., was appointed Vice-Chancellor, in succession to Prof. Weiss, whose resignation takes effect in September. The nomination of Sir Henry Miers had previously received the unanimous approval of the Senate and Council. Since the resignation of Sir Alfred Hopkinson arrangements have been made to lighten the administrative duties of the Vice-Chancellorship, and it is hoped that in the appointment of a distinguished man of science to this office additional strength may be given to the advanced teaching and research work of the University. A proposal will shortly be brought forward to establish a professorship of crystallography, to which the new Vice-Chancellor will be appointed.

OXFORD.—The friends of the late Mr. Arthur Elam Haigh, sometime fellow of Hertford and fellow and tutor of Corpus Christi College, Oxford, will have heard with regret of the death of his elder son, Lieut. Charles Roderick Haigh, Adjutant of the 2nd Battalion Royal West Surrey Regiment, who was killed in action in Belgium on November 7. Lieut. C. R. Haigh has left several large bequests to educational and charitable objects, among them being the establishment of a scholarship at Corpus Christi College and another at Leeds Grammar School, both in memory of his father. There are further bequests to Winchester College, to the Oxford Preparatory School, to Oxford Temperance and Surgical Aid Societies, and to his old regiment.

The University has adopted a series of decrees allow a certain relaxation of the regulations concerning the keeping of terms and payment of dues in the case of those of its members who are serving in the war.

IT is announced in the issue of *Science* for January 22 that Pomona College, Claremont, Cal., has completed the collection of an endowment fund of 200,000*l.* towards which the General Education Board contributed 30,000*l.*; also that Mrs. Russell Sage, who had undertaken to give 20,000*l.* towards a 100,000*l.* dining hall for Princeton University, has increased her offer to 50,000*l.*, provided an equal sum is collected by July 1. Sums amounting to 15,000*l.* have been subscribed.

COMMENTING upon an article in the January issue of the Technical Journal of the Association of Teachers in Technical Institutions on the Massachusetts Institute of Technology in NATURE for January 21 (vol. xciv., p. 580), we reminded our readers that in this well-known college there is a continual weeding out of those students who do not display the requisite ability and application. We might have added that this plan is common in American institutions of higher education, and is adopted in many of our own technical colleges. In the faculty of engineering of the University of Bristol, for example, Prof. J.

Wertheimer writes to say that the system has prevailed for many years, and that it has resulted in a great increase of efficiency and in an improved prestige of the college in the eyes of the heads of the firms which employ students who have gone through their engineering training at Bristol.

THE King has appointed a new Royal Commission for the following purposes:—To inquire into and report on the methods of making appointments to and promotions in the Civil Service, including the Diplomatic and Consular Services, and the legal departments; to investigate the working and efficiency of the system of competitive examination for such appointments, and to make recommendations for any alterations or improvements in that system which may appear to be advisable; and to consider whether the existing scheme of organisation meets the requirements of the Public Service, and to suggest any modifications which may be needed therein. The members of the Commission are as follows:—Sir H. B. Smith (chairman), Duke of Devonshire, Bishop of Southwark, Sir J. P. Hewett, Sir Donald Macalister, Sir J. A. Kempe, Mr. S. J. G. Hoare, Mr. A. C. T. Beck, Mr. A. A. Booth, Mr. A. Boutwood, Mr. J. R. Clynes, Mr. C. Coward, Mr. R. D. Holt, Mr. P. E. Matheson, Dr. A. E. Shipley, Mr. P. Snowden, Mr. Graham Wallas, Miss E. S. Haldane, and Mrs. L. A. E. Streatfeild.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 28.—Sir William Crooks, president, in the chair.—W. W. C. **Topley**: The influence of salt-concentration on hæmolysis. The method employed in this investigation has consisted in varying the percentage of sodium chloride present in a mixture of sheep's red cells, hæmolytic anti-body and complement. The hæmolytic anti-body was obtained from an immunised rabbit, and fresh guinea-pig serum, previously absorbed with sheep's red cells at 0° C., furnished the complement. Where hypotonic percentages of sodium chloride have been employed, the solutions have been made in 7·8 per cent. saccharose solution. The results have confirmed the observations of other workers that, when the percentage of salt is increased beyond the normal limit, hæmolysis is inhibited, owing to the failure of union between the complement and the red-cell anti-body complex, and that, if the amount of anti-body present in the mixture be increased, the effect of the increased salt concentration may to a certain extent be overcome. It has further been shown that, if the salt concentration be decreased below the normal limits, less and less anti-body becomes necessary in order to bring about the union of red cells and complement, and that, in the almost entire absence of electrolytes, guinea-pigs' complement can hæmolyse sheep's red cells without the intervention of hæmolytic anti-body.—G. **Smith**: The life-cycle of Cladocera, with remarks on the physiology of growth and reproduction in Crustacea. As the result of breeding experiments, it is shown that the effects of isolation, crowding, and temperature are the same for *Daphnia pulex* as previously reported for *Moina rectirostris*, viz., isolation combined with high temperature completely inhibits the production of sexual individuals, reproduction being entirely parthenogenetic. Crowding, combined with low temperature, results sooner or later in the production of males and ephippial females.—T. **Goodey**: Investigations on protozoa in relation to the factor limiting bacterial activity in soil. Two different lots of soil were taken and inoculated with cultures of protozoa originally obtained from soil, in order to determine whether the added protozoa would cause a decrease in the numbers of bacteria in the soil. One soil was free from protozoa to begin with, having been bottled since 1846, whilst the other was freed from protozoa by partial sterilisation. Separate lots of each soil were inoculated with cultures of ciliates, amœbæ, and flagellates, and suitable control samples were set up. Periodical bacterial counts were made in order to ascertain if the protozoa were exerting a limiting action on the soil bacteria, and these counts were continued over a period of about eighteen months. The general conclusion drawn from the investigations is that ciliates, amœbæ, and flagellates do not act as the factor limiting bacterial activity in soil.—S. **Hatta**: The mesodermic origin and fate of the so-called mesectoderm in petromyzon. The name mesectoderm has given to a loose aggregation of mesenchymatous tissue, in some places assuming the character of an epithelium intervening between the myotomes and the ectoderm in the head and branchial region of the embryo of petromyzon. As the name implies, it has been confidently asserted that this tissue is derived from the ectoderm. In this paper, however, it is shown that this tissue originates from the ventral edge of the myotome and corresponds to the ventral extension of the myotome in the trunk region which grows downwards towards the mid-ventral line outside the splanchnocœle and gives rise to the ventral muscles of the trunk.—Prof. J. C. **Bose**: The influence of homodromous and heterodromous electric currents on transmission of excitation in plant and animal. The action of an electric current in inducing variation of conductivity may be enunciated under the following laws, which are equally applicable to the conducting tissue of the plant and the nerve of the animal:—(1) The passage of a current induces a variation of conductivity, the effect depending on the direction and intensity of current. (2) Under feeble intensity, heterodromous current enhances and homodromous current depresses the conduction of excitation. (3) The after-effect of a feeble current is a transient conductivity-variation, the sign of which is opposite to that induced during the continuation of current. (4) The normal conductivity-variation undergoes a reversal under a strength of current above the critical value. The heterodromous current then induces a depression while the homodromous current induces an enhancement of conductivity.

Geological Society, January 20.—Dr. A. Smith Woodward, president, in the chair.—Prof. O. T. **Jones** and W. J. **Pugh**: The geology of the district around Machynlleth and the Llyfnant Valley. An account is given of the physical features, general succession, and structure of the area. The rocks are sharply folded, and sometimes overfolded, towards the east. Their axes range approximately north-north-east and south-south-west; the folds in the central area pitch northwards, but north of the Dovey a southerly pitch sets in. Each large fold is composed of a number of smaller folds having parallel axes, and changing in pitch more frequently than the larger folds. Strike-faults of considerable magnitude range nearly parallel with the folding axes, and are in all cases overthrusts towards the east. Of interest are the transverse faults ranging nearly east-north-east and west-south-west. Two of these faults, the Pennal and Llyfnant Faults, are shatter-belts. The Llyfnant Fault displaces several folding axes, and overthrusts to the east on the north side. Its vertical displacement is on an average about 300 ft., but its horizontal displacement is usually more than 3000 ft. It may therefore be called a "tear-fault."—Dr. A. H. **Cox**: The geology of the district between Abereiddy and Abercastle (Pembrokeshire). The stratigraphy and structure of the greater part of the district is described for the first time. Abereiddy itself has been, since the time of Hicks, a type-locality for the Llanvirn Beds. It has been found that the Ordovician rocks of the district do not succeed one another in a simple upward sequence, but that they have been thrown into great folds and sometimes even overfolded. The limbs of the folds increase in steepness as the pre-Cambrian massif is approached. This folding brings up strips of Cambrian rocks, the presence of which on the North Pembrokeshire coast was previously unsuspected. There is a complete sequence of Ordovician rocks from near the base of the Arenig Series to high up in the Glenkiln Group.

Linnean Society, January 21.—Prof. E. B. Poulton, president in the chair.—W. J. **Dakin**: Structure and fauna of the Abrolhos Islands. Percy Sladen Trust Expedition. The islands are situated 40–50 miles off the coast of West Australia. They are interesting because of the almost complete lack of knowledge concerning the marine fauna of that part of the world. In addition, however, they possess many peculiar features of their own. Although they are coral islands (the most southern in the world), the land fauna is decidedly continental and indicates a comparatively recent connection with the mainland of Australia. Again, although the coast is only forty miles east of the islands, one has to travel some hundreds of miles north of the latitude of the Abrolhos to find a marine fauna on the coast with such tropical characters. The collections have not yet been worked out, but not the least interesting of the discoveries is a new species of Enteropneusta, *Ptychodera pelsarti*, closely allied to varieties of *Pt. flava*. This is the first Enteropneust known from the West Coast of Australia.

Institution of Mining and Metallurgy, January 21.—Mr. Bedford McNeill, past president, in the chair.—J. A. L. **Henderson** and W. H. **Henderson**: Inflammable natural gas as an economic mineral. The authors set out to show that natural petroleum-gas is the only inflammable natural gas of economic value, in its two divisions of "dry" or gas-well gas, and "wet" or "casing-head" gas, which is chiefly produced from oil wells. The former is of chief commercial importance, as it is capable of direct use for heating, power, and lighting purposes as it comes from the well. The occurrence of natural petroleum is co-extensive with that of petroleum, though the reverse is not always true, as is shown by the relative acreages of gas and oil fields in the United States in 1911, which were 11,132,642 and 8,322,862 respectively. The greatest and most extensive natural gas deposits of economic importance, so far as known, are found in the older, drier, and more consolidated porous sedimentary rocks from the Cretaceous downward. In the United States the industry has developed to such an extent that in 1913 the value of natural gas produced almost equalled that of the gold produced. Natural gas has within the last ten to fifteen years become a formidable rival to petroleum in output, and even in value, despite the enhanced prices that the oil has commanded in recent years. In addition to the gas production of the United States, which easily stands first, the authors direct attention to the occurrences in Canada, Russia, Galicia, Italy, Transylvania, and even in England.—J. **Cook**: Investigations in ore milling to ascertain the heat developed in crushing. As the result of carefully conducted experiments with an electrically driven stamp mill the author established the following data: Of the E.H.P. supplied to the motor only 76 per cent. was apparently stored in the raised stamp; the ore crushed was raised in temperature an average of 4·8° C., while the water used was raised an average of 0·438° C. Of the actual E.H.P. put into the motor, practically 61 per cent. was returned as heat in the pulp. Of the energy which reached and was stored in the lifted stamp, practically 80 per cent. was returned as heat in the escaping pulp. In the latter case the author allocates the remaining 20 per cent. unaccounted for as heat to (*a*) loss by friction of the guides, (*b*) loss in sound and vibration, (*c*) loss in radiated heat, and (*d*) the larger proportion, loss due to the energy with which the pulp is delivered through the screens. The test was borne out by the fact that the screens had in places a perceptibly higher temperature than the pulp. The author asks: Is the energy used in tearing the ore particles asunder entirely returned as heat, and do some electrical phenomena exist?

Mineralogical Society, January 26.—Dr. A. E. H. Tutton, president, in the chair.—S. **Kôzu**: The dispersion of felspar. By the most refined methods the dispersions in the three principal directions were determined for various members of the felspar group.—F. P. **Mennell**: Note on the colour of some alluvial diamonds and of pyrrhotite. The colour, usually green, of the diamonds in the gravels of Somabula, Rhodesia, is superficial, and probably due to infiltration, presumably of iron salts, while the stones were lying where they now occur. Pyrrhotite is tin-white in colour when fresh. The cause of its rapid alteration was discussed.—Prof. G. **Cesàro**: Crystals of calomel from Spain. The crystals, which were pale-yellowish in colour, imperfectly transparent, from 1–3 mm. in size, and displaying the forms 100, 111, 311, were most irregularly developed.—Prof. G. **Cesàro**: General formula for the birefringence of a crystal-plate in terms of the angles which its normal makes with the principal optical axes. The approximate formula is obtained by supposing the mean index of refraction to become infinite, while the differences between it and the greatest and least indices remain constant.—Prof. G. **Cesàro**: A numerical relation of the sum of the symmetry-axes situated in the symmetry-planes of a polyhedron. If $N . \Lambda_n$, $P . \Lambda_p$, $Q . \Lambda_q \ldots$ are the axes of symmetry lying in the planes of symmetry, then—

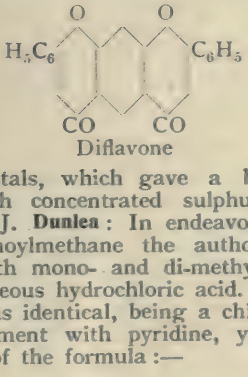
$$4\{Nn(n-1)+Pp(p-1)+Qq(q-1)+\ldots\}+1=C,$$

and the number of planes of symmetry is given by $X=\frac{1}{2}(C+1)$.

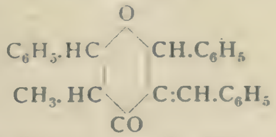
DUBLIN.

Royal Irish Academy, January 11.—Rev. J. P. Mahaffy, president, in the chair.—S. B. **Kelleher**: A three-dimensional complex variable. Some properties of expressions of the form $P+Q\theta+R\theta^2$ where P, Q, R are functions of three independent variables and θ^3 is equal to unity, but $1+\theta+\theta^2$ is not zero.—R. **Southern**: Summary on marine distribution (Clare Island Survey). This paper is in the nature of a summary of the results obtained by the investigation of the marine fauna of the Clare Island area. The nature of the coast-line and sea-bottom is described, and the various types of habitat and the associations of animals inhabiting them are discussed. The distribution of the fauna from the geographical point of view is then considered. Some observations on the period of reproductive activity of various species are included. A description of the hydrographical results obtained in the course of the survey is given. The total number of marine species of animals obtained in the course of the survey is approximately two thousand, a much larger number than has hitherto been found in any similar area.—R. **Lloyd Praeger**: Summary on terrestrial distribution (Clare Island Survey). The work of the Clare Island Survey now closing has occupied just six years, the first three being devoted to field-work and the last four to publication, there being an overlap of one year in the two sections. More than one hundred workers took part, and without exception the authors of the sixty-eight reports in which the results are embodied themselves visited the area. Besides papers on almost every group of the plant and animal kingdoms, the report includes contributions on the history and archæology of the area, on Gaelic names of animals, plants, places, and human families, climatology, and geology. The total number of species of animals obtained is about 5100, and of plants about 3200, total more than 8300. Of these no fewer than 1825 are additions to the fauna or flora of Ireland. More than 400 are new records for the British Isles, and more than 120 are new to science. Two new families and fifteen new genera are described.

January 25.—Dr. F. A. Tarleton, in the chair.—H. **Ryan** and Miss P. **O'Neill**: Studies in the diflavone group.—I., Diflavone. With the view of extending our knowledge of the relations between constitution and colour in the oxygen dyes, the authors have prepared a substance which has, as its formula, two flavone rings in a condensed form. It was obtained from diacetoresorcinol in two ways:—(1) Diacetoresorcinol dimethyl ether was condensed with benzaldehyde to dihydroxydichalkone dimethyl ether which reacted with aluminium chloride to give dihydroxydichalkone and the tetrabromide of the diacetate of dihydroxydichalkone on treatment with alcoholic potash yielded diflavone. (2) Dibenzoylacetoresorcinol dimethyl ether was formed by condensation of benzoic ester with diacetoresorcinol dimethyl ether, and was converted by hydriodic acid into benzoylacetomethoxyflavone, and finally into diflavone. The latter formed pale yellow crystals, which gave a beautiful blue fluorescence with concentrated sulphuric acid.—H. **Ryan** and Rev. J. **Dunlea**: In endeavouring to synthesise dicinnamoylmethane the authors condensed benzaldehyde with mono- and di-methylacetylacetone by means of gaseous hydrochloric acid. The product in both cases was identical, being a chlorinated body which, on treatment with pyridine, yielded a substituted pyrone of the formula:—



Diflavone



The substance did not form an oxime, but added on hydroxylamine apparently at the unsaturated linkage It formed a dibromo-derivative.

PARIS.

Academy of Sciences, January 23.—M. Ed. Perrier in the chair.—G. **Bigourdan**: Description of a new instrument for the differential comparison of great angular distances in the sky. A movable platform carrying two telescopes is fixed to an equatorial mounting in such a manner that the axis about which the platform can move coincides with position usually occupied by the optical axis of the equatorial. The two telescopes can turn round axes normal to the platform, and are furnished with ocular micrometers. The use of the instrument, which forms a sort of angular comparator, is described. It will prove specially suitable for the direct determination of refraction, the measurement of the annual aberration constant, and correcting the fundamental star catalogues by comparison of large differences of right ascension, independently of clocks and of variation of instrumental constants.—André **Blondel**: The useful effect of projectors. Additional remarks.—E. **Delorme**: New treatment of nerves wounded by projectiles. The general principles underlying nerve operations are stated, together with full details of the methods employed.—J. **Bosler**: The red region of the spectrum of stars of the Wolf-Rayet type. Photographs of the red end of the spectrum of fifteen stars of this type, utilising plates sensitised by means of dicyanine. Comparison of the spectra confirms the view that stars of the Wolf-Rayet type represent waning Novæ of past ages. New stars appear generally in dense star clusters, and the Wolf-Rayet stars also have the same peculiarity.—F. **Devoto**: Observations of Delavan's comet (1913*f*) made at the Paris Observatory. Observations and positions of comparison stars are given for December 24, 28 (two), 29, January 8, 11, 18.—S. **Stoilow**: Quadruply periodic functions.—Paul **Mansion**: Demonstration of the law of large numbers. —Stanislas **Meunier**: A remarkable consequence of volcanic theory.—Emile **Belot**: Orogenic theory arising from the physical theory of the formation of oceans and primitive continents.—Edmond **Gain** and A. **Jungelson**: Maize seeds resulting from the growth of free embryos. The embryos were extracted from the seeds, carefully cleaned from all reserves of albumen, and sown in natural soil. The plants obtained produced seed of normal type.—H. **Jumelle** and H. Perrier de la **Bâthie**: A slightly known Cucurbitaceæ of Madagascar.—MM. **Rivier** and **Dupoux**: A new method for the rapid production of radiographs on ferrotype plates.—P. **Carnot** and B. **Weill-Hallé**: Culture in sand tubes for the rapid diagnosis of typhoid fever, and searching for germ-carriers.—Henri **Coupin**: The organic nutrition of a marine bacterium. A. **Trillat**: Study on the aqueous microbial dusts of inhabited places.

BOOKS RECEIVED.

University of Melbourne. Medical School Jubilee. Pp. 108. (Melbourne: Ford and Son.)

The Observer's Handbook for 1915. Pp. 76. (Toronto: Royal Astronomical Society of Canada.)

Anuario del Observatorio de Madrid. Para 1915. Pp. 703. (Madrid: Bailly-Baillière.)

Memoirs of the Geological Survey. England and Wales. The Geology of the South Wales Coalfield. Part xi. The Country around Haverfordwest. Pp. viii+262. (London: H.M.S.O.; E. Stanford, Ltd.) 3*s*. 6*d*.

Memoirs of the Geological Survey. Scotland. The Geology of the Country round Beauly and Inverness, including a Part of the Black Isle. Pp. vi+108. (London: H.M.S.O.; E. Stanford, Ltd.) 2*s*.

Genetic Studies on a Cavy Species Cross. By Prof. J. A. Detlefsen. Pp. 134+10 plates. (Washington: Carnegie Institution.)

A Pilgrim's Scrip. By R. Campbell Thompson. Pp. xii+345. (London: J. Lane.) 12*s*. 6*d*. net.

An Introduction to the Study of Colour Vision. By Dr. J. H. Parsons. Pp. viii+308. (Cambridge University Press.) 12*s.* 6*d.* net.

Smithsonian Miscellaneous Collections. Vol. lxiii., No. 8. Explorations and Field-Work of the Smithsonian Institution in 1913. Pp. 88. Vol. lxiii., No. 9. The Olfactory Sense of Insects. By Dr. N. E. McIndoo. Pp. 63. (Washington: Smithsonian Institution.)

Insects and Man. By C. A. Ealand. Pp. 343. (London: Grant Richards, Ltd.) 12*s.* net.

An Atlas of Economic Geography. By Dr. J. G. Bartholomew, with Introduction by Prof. L. W. Lyde. Pp. lxvi+96 pages and of maps. (London: Oxford University Press.) 5*s.* net.

Determinacion de la Hora por Alturas Absolutas, Correspondientes é Iguales de Distintas Estrellas. By C. Puente. Pp. 211. (Madrid: Bailly-Baillière.)

The Principles of Understanding: An Introduction to Logic from the Standpoint of Personal Idealism. By H. Sturt. Pp. xiv+302. (Cambridge University Press.) 5*s.* net.

Oxford Outline Maps. Nine (various). (Oxford: Clarendon Press.) 1*d.* each.

Alternating-Current Electricity and its Applications to Industry. First Course. By W. H. Timbie and Prof. H. H. Higbie. Pp. x+534. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s.* 6*d.* net.

Studies of Trees. By J. J. Levison. Pp. x+253. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 7*s.* net.

Air, Water, and Food, from a Sanitary Standpoint. By A. G. Woodman and J. F. Norton. Fourth edition. Pp. v+248. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s.* 6*d.* net.

Electricity in Gases. By Prof. J. S. Townsend. Pp. xv+496. (Oxford: Clarendon Press.) 14*s.* net.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1915. (London: H. Greenwood and Co., Ltd.) 1*s.* net.

The Vicious Circles of Neurasthenia and their Treatment. By Dr. J. B. Hurry. Pp. xv+90. (London: J. and A. Churchill.) 3*s.* 6*d.* net.

The Lonely Nietzsche. By Frau Forster Nietzsche. Translated by P. V. Cohn. Pp. xv+415. (London: W. Heinemann.) 15*s.* net.

A Text Book of General Physics for College Students: Electricity, Electromagnetic Waves, and Sound. By Prof. J. A. Culler. Pp. x+321. (Philadelphia and London: J. B. Lippincott Co.) 7*s.* 6*d.* net.

The Royal Botanic Society of London Pocket Book. Pp. 62. (London: Royal Botanic Society.) 1*s.*

DIARY OF SOCIETIES.

THURSDAY, February 4.

Royal Society, at 4.30.—Discontinuous Fluid Motion Past a Bent Plane, with Special Reference to Aeroplane Problems: Prof. G. H. Bryan and R. Jones.—A New Type of Series in the Band Spectrum Associated with Helium: Prof. A. Fowler.—The Spectra of Ordinary Lead and Lead of Radio-active Origin: T. R. Merton.—The Viscosity of the Vapour of Iodine: A. O. Rankine.

Royal Institution, at 3.—Modern Theories and Methods in Medicine Methods and Results: H. G. Plimmer.

Linnean Society, at 5.—A New, Well-petrified Fossil: Wood or Bark Angiosperm or Gymnosperm?: Dr. Marie Stopes.—Brachydactyly as an Example of Mendelian Inheritance: Dr. H. Drinkwater.

FRIDAY. February 5.

Royal Institution, at 9.—Science and Industrial Problems: Prof. A. W. Crossley.

Geologists' Association, at 7.30.—Annual General Meeting.—Presidential Address: Geological History of Flying Vertebrates: G. W. Young.

MONDAY, February 8.

Royal Geographical Society, at 8.30.—A Seventh Journey in Persia: Col. P. Molesworth Sykes, C.M.G.

TUESDAY, February 9.

Zoological Society, at 5.30.—Exhibition of Skins of Mammals from Sierra Leone: Guy Aylmer.—Exhibitions of Skiagraphs of Foraminifera: E. Heron-Allen.—Report on the Deaths which occurred in the Zoological Gardens during 1914: H. G. Plimmer.—A Colubrid Snake (Xenodon) with a Vertically Movable Maxillary Bone: E. G. Boulenger.—A New Liver-fluke from the Kestrel: W. Nicoll.

Royal Institution, at 3.—Muscle in the Service of Nerve: Prof. C. S. Sherrington.

Institution of Civil Engineers, at 8.—Engineering Operations for the Prevention of Malaria: F. D. Evans.

WEDNESDAY, February 10.

Royal Society of Arts, at 8.—British Lithography in 1915: F. V. Brooks.

THURSDAY, February 11.

Royal Society, at 4.30.—*Probable Papers: Lepidostrobus Kentuckiensis*, formerly *Lepidostrobus Fischeri*, Scott and Jeffrey; A Correction: Dr. D. H. Scott.—The Excitatory Process in the Dog's Heart. II.: The Ventricles: T. Lewis and M. A. Rothschild.—The Variation in the Growth of Mammalian Tissue *in vitro* according to the Age of the Animal: A. J. Walton.

Royal Institution, at 3.—Nations as Species: Dr. P. Chalmers Mitchell.

Institution of Electrical Engineers at 8.—Conditions Affecting the Variation in Strength of Wireless Signals: Prof. E. W. Marchant.

Child Study Society, at 6.—With the British Association in Australia: Dr. C. W. Kimmins.

Royal Society of Arts, at 4.30.—Tribes of the Brahmaputra Valley: Capt. Sir George D. Dunbar, Bart.

FRIDAY, February 12.

Royal Institution, at 9.—Recent Advances in Oceanography Dr. W. S. Bruce.

Royal Astronomical Society, at 5.—Anniversary Meeting.

Physical Society, at 8.—Annual General Meeting.—The Criterion of Steel Suitable for Permanent Magnets: Prof. Silvanus P. Thompson.—A Galvanic Cell which Reverses its Polarity when Illuminated: Alan A. Campbell Swinton.—An Investigation on the Photographic Effect of Recoil Atoms: A. B. Wood and A. I. Steven.

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THURSDAY, FEBRUARY 11, 1915.

THE REAL JAPAN.

Japan To-day and To-morrow. By H. W. Mabie. Pp. ix+291. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

THIS book makes little attempt to give the history of Japan or to describe the country or its political or naval and military development. It is, we think, a successful attempt to understand the Japanese temper, character, spirit, and genius. In material things the Japanese have altered altogether in the last sixty years, but in spiritual things they have altered very little. The traveller describing faithfully what he sees is usually ignorant of the things described in this book, but these are the things which it is most important for the statesmen of other countries to know. Mr. Mabie is an American, and he is anxious that Americans particularly shall look below the surface of things. He shows that the genius of a people eludes the direct search for it, and he looks for its revelation not in universities and courts, but in shops and fields and homes.

> "It is a people whose government has been religious, whose religion has been governmental, and whose whole organised life has been like a garment woven out of the substance which it clothes, but does not conceal."

Customs have always had the authority of law. The soul of Japan is in Shintoism, which is no longer a religion; it is not only a living source of poetry, it is a profound national sentiment of tremendous energy. Strangers expressed only admiration for Japan forty or fifty years ago. As the Japanese realised that great resources were absolutely necessary for their existence, they turned to commerce and manufacture; then they were said to have become dishonest and their politeness had become insincerity. We have heard the same undiscerning kind of criticism of European people. The Japanese are in essentials just what they used to be. Their ways of thinking, their ideals, their standards of life, and their interpretations of the mystery of the world are different from ours, simply because for thousands of years they and we have lived unknown to each other. But these differences between us are only superficial, although Mr. Kipling holds another view.

The man who frequents the smoking-rooms of clubs and hotels cannot see the things described by Mr. Mabie, and ninety-nine per cent. of the business men who live in Japan and think they know all about it are quite ignorant of the intellectual movements, the spiritual stirrings in the souls of those among whom they have their home, but with whom they do not live. The Germans specially have shown contempt for the Japanese; even their highest classes have shown in this way their intellectual limitation. The parrot-cry that the Japanese have no originality—that they are merely imitative—comes from unobservant men. The Japanese have a passion for work; their hands and brains are always on intimate terms. One and all they are artists, and artists always possess freedom and the energy of personality. *Jiujitsu*, the endeavour to set skill against force and intelligence against mass is emblematic of one great characteristic of these people, which is perhaps most visible in their art, "the full weight of thought without any weight of expression." The Japanese will probably solve for Europe many of its seemingly insoluble problems.

This book is one that ought to be studied not only by people who wish to know something of the real soul of Japan, but also by all people who wish to keep their own souls alive.

JOHN PERRY.

LAMARCK'S EVOLUTION THEORY.

Zoological Philosophy: an Exposition with regard to the Natural History of Animals. By J. B. Lamarck. Translated by H. Elliot. Pp. xcii+410. (London: Macmillan and Co., Ltd., 1914.) Price 15*s.* net.

MR. ELLIOT has done a valuable piece of work in making a complete translation of Lamarck's "Philosophie Zoologique," which was published in 1809, half a century before Darwin's "Origin of Species," and is undeniably one of the evolution classics. He has enabled students of organic evolution who are unfamiliar with French, or who have been repelled by Lamarck's tedious style, to get a first-hand knowledge of the doctrines of one of the greatest of Darwin's predecessors. Recognising that the main interest of the "Philosophie Zoologique" is historical, Mr. Elliot has given a very literal translation, taking few liberties beyond breaking up some of the very long sentences, and altering words the meaning of which has greatly changed during the past century. A useful list is given of many of the French terms with the translations adopted. It must be confessed that there are manv pages, especially those dealing with the classification of animals and with physiology, which are of little importance, but the value of having a complete translation is obvious. The alternative of making a selection of the salient passages is always a hazardous procedure. It seems to us that Mr. Elliot did wisely in translating the whole, and that he has executed this laborious piece of work with care and skill.

As the author must have been saturated with Lamarck's views for a prolonged period, it is interesting to read his introduction, where the essentials of Lamarck's teaching are explained. We shall refer to a few. It is pointed out, for instance, that Lamarck's picture of a continuous scale of being from Monad to Man (the taxonomic punctuation being simply a matter of convenience) was associated with his denial that species had ever become extinct. Apparently peculiar fossils have, he maintained, their living representatives, though they may not have been discovered.

Reacting from the doctrine of fixity of species, Lamarck went to the other extreme of exaggerating their instability. Evolution he believed to have come about by minute steps only. The factors were two—an innate tendency to complexify and the hereditary accumulation of changes induced by peculiarities in function (use and disuse). These peculiarities may have arisen as responses to changes of environment, but he expressly excludes the direct action of the environment as an operative cause.

In discussing the question of the transmission of modifications, Mr. Elliot refers to an interesting and illuminating suggestion by Prof. MacBride that hormones may afford a clue to a possible *modus operandi* of transmission. Unless we have misunderstood, a similar suggestion was made by Mr. J. T. Cunningham in 1908, and the idea is also implied in a passage in the "Creative Evolution" by Prof. Bergson, with whose "illusions" Mr. Elliot is familiar. We refer to the point simply because these coincidences of thinking are always of interest.

Mr. Elliot says on p. 49 that if environmental factors come into action after birth or before it in the course of development they produce a *modification,* apparently *not* heritable. If they come into action before development begins, they produce a *variation* which *is* heritable. In his exceedingly important experiments on Simocephalus, Dr. W. E. Agar has shown that a change induced in the egg-cells along with the body of the parent had its influence on the individuals developing from these ova, and slightly on the next generation, and then waned away. In the light of this fact and Dr. Agar's interpretation, Mr. Elliot's view requires correction.

One of the interesting conclusions of Lamarck's physiology was that nervous impulse is due to a "nervous fluid," which is an "animalised" form of the electric fluid. He reached this conclusion by showing that no other theory worked, and Mr. Elliot finds obvious satisfaction in showing that this is the *per exclusionem* method used by Dr. Hans Driesch and others to prove the existence of a vital force or Entelechy. The fallacy is the familiar one that we have first to be sure that all the possible alternatives are before us. Mr. Elliot simplifies things by assuring us that "every event, that receives a scientific explanation, is analysed into some particular combination of matter and material energy." A reflex action, for instance, is "of a purely mechanical nature." But this, like the vitalist's declaration that there must be a "vital force," is an assertion that outstrips its evidence, as Prof. Sherrington's work plainly shows.

Lamarck was shrewdly opposed to postulating entities such as a vital principle or even "esprit," and was on the whole mechanistic. Yet we must bear in mind that one of the distinctive features of his teaching was the important evolutionary *rôle* which he ascribed to the "emotions of the inner feeling," which are excited by "needs," and give rise to actions at once satisfying and transforming. Of this and many other matters Mr. Elliot has much that is interesting to say, though we think his philosophy is sadly out of repair.

J. A. T.

GENERAL AND SPECIALISED GEOLOGY.

(1) *A First Book of Geology.* By Dr. A. Wilmore. Pp. vi + 141. (London: Macmillan and Co., Ltd., 1914.) Price 1*s*. 6*d*.

(2) *An Introduction to the Geology of New South Wales.* By C. A. Süssmilch. Pp. xviii + 269. Second edition. (Sydney: Angus and Robertson; London: Oxford University Press, 1914.) Price 7*s*. 6*d*. net.

(1) DR. WILMORE'S "first book" of geology presumably completes the admirable series that includes, under the care of the same publishers, the works of Prof. Watts and Sir Archibald Geikie, and culminates in the latter's monumental "Text-book." The landscape illustrations are clear and well chosen; we may specially mention Mr. Harrison's tors on Dartmoor, and the Sligo peat-bog, with Ben Bulben in the background, by Mr. Welch (of Belfast, not Dublin). Without any appearance of crowding, a remarkable amount of fundamental information is included here in 140 pages. Practical work is encouraged, and the book is well suited for schools. The fact that the dip is the greatest possible angle of those that might be read with the clinometer should be emphasised on p. 32. The fine picture of Vesuvius on p. 43 represents the well known eruption of 1872, not 1892. A figure 2 is missing from the olivine formula on p. 54; water is omitted from that for gypsum on p. 94;

and the use of the word "foliæ" and the classical derivations generally require revision. A new edition of so attractive a book will soon be called for. We note that such modern points of interest as the lava-plug of Mt. Pelée and the wanderings of pebbles from Ailsa Craig find a place in this lucid introduction to geology.

(2) Mr. Süssmilch's work on New South Wales is an enlarged edition of that published in 1911 (see NATURE, vol. xc., p. 590). It deals only briefly with surface-features, and is intended for readers who already possess a knowledge of general geology and of the terminology of the science. Such readers, we have reason to believe, are far more prevalent in colonies where mining development has been active than they are in our own islands, where exploration is practically complete. The success of Mr. Süssmilch's book indicates a good educational level in New South Wales. It is well illustrated by photographs, maps, and sections; among the last, those of the Permo-Carboniferous (late Carboniferous and Permian) coal-basins, in which glacial horizons occur, are of especial interest. The fresh-water conditions under which Triassic and Jurassic strata were deposited are dealt with in chapter xi., and the origin of the artesian water is touched on at the close. The latest publication, by the by, on this important and much-disputed question has been issued by the Department of Mines for New South Wales (E. F. Pittman, on "The Great Australian Artesian Basin"), and contains a detailed criticism of Prof. Gregory's views on the magmatic nature of the supply. Mr. Süssmilch "prefers at present to suspend judgment," and Mr. Pittman's paper, with its remarkably extensive bibliography, must now be consulted by those who are willing to go further.

The vegetation of successive periods in Australia is fully as interesting as the faunas. That of the Cretaceous period is known in New South Wales by conifers alone. The Glossopteris flora marks the Permo-Carboniferous horizons, while a Rhacopteris flora characterises the underlying Carboniferous beds (p. 89). We note that Archæopteris is quoted from the Lower Devonian estuarine shales of the Genoa River and from the Rhacopteris series in the Carboniferous. The author (p. 84) inclines to divide the "so-called Gympie beds," placing some of them, containing *Lepidodendron australe*, with the Lepidodendron beds of Devonian age.

The pictures of fossils are excellent, and the book is a pleasant addition to the growing library of the empire. Misprints are extremely rare; the spelling "Kosciusko" has long received geographical sanction.

G. A. J. C.

OUR BOOKSHELF.

Logic, Deductive and Inductive. By Carveth Read. Fourth Edition. Pp. xvi+417. (London: A. Moring, Ltd., 1914.) Price 6s.

As this is the fourth edition—though enlarged and partly re-written—of the work under notice, it is not necessary to review it in detail. It is sufficient to mention, by way of reminder, that for the most part it follows the schemes of J. S. Mill and Prof. Bain, beginning with propositions and terms, and moving through the syllogism to induction, then dealing with causation, hypotheses, and fallacies. Perhaps the treatment of hypotheses might be noticed as specially interesting and good, the difference between hypothesis and theory being well brought out. Also, the nature of proof, *e.g.*, is very neatly put: "If a new agent be proposed, it is desirable that we should be able directly to observe it, or at least to obtain some evidence of its existence of a different kind from the very facts which it has been invented to explain" (p. 270). It is also well pointed out that science is a "way of thinking," and that though we inevitably follow perceptual analogies in our hypotheses—thinking of atoms and æther as perceptible things, which they are not—these hypotheses are useful even if wrong. There is no reason to be afraid of inventing an hypothesis. Ockham's razor may be too vigorously plied. We live by hypotheses in the affairs of daily life. If I lose my fountain-pen, I guess where it is, and then go to verify or disprove. So with science, the discoveries of which are often inspired guesses.

Oxford Outline Maps. Edited by Prof. A. J. Herbertson. (Oxford University Press.) Price 1*d*. net each, 9*d*. net for 12 of one kind, 1*s*. 4*d*. net for 25 of one kind.

THESE outline maps have been drawn for use in the exercises contained in the text-books of geography, of which Prof. Herbertson is the author, issued by the same publishers, but they will accompany usefully other modern class-books of geography. The maps are clear and well chosen, and are evidently the work of a cartographer familiar with the needs of schools.

Air, Water, and Food from a Sanitary Standpoint. By A. G. Woodman and J. F. Norton. Pp. v.+248. Fourth edition. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1914.) Price 8*s*. 6*d*. net.

THE first edition of this book, which was by the late Mrs. Ellen H. Richards and Prof. A. G. Woodman, was reviewed in the issue of NATURE for October 25, 1900 (vol. lxii, p. 620). The book was first written from a "missionary" point of view, but actually became used in colleges and technical schools, and the present authors have changed somewhat the character of parts of the volume. All the discussion on air and water has been rewritten, the section on milk has been recast, and numerous additions have been made throughout.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

A Penalty on Research.

WE are frequently told that there is no difficulty in being accorded the use of small quantities of absolute alcohol, duty-free. While professor at University College, it was possible for me to procure what I required, duty-free, for a permit had been granted to the college. Now, working in my private laboratory here, I am refused the privilege. Having applied for permission to be allowed to buy not more than two gallons a year of absolute alcohol, free of duty, the secretary, in a letter of February 1, says:—"The Commissioners regret their inability to grant you the use of pure spirit, duty-free."

Now, sir, I have lately been doing a good deal of work for various departments of the Government free of charge; and for some of this, absolute alcohol is, if not a necessity, at least a great convenience. Moreover, my laboratory servant, who is, by the way, a teetotaler, is serving with the colours.

I regard this action of the Customs Department as a penalty on research. No doubt it will be said, if an exception (exception to what?) is made in one case, why not in all? The privilege might be abused. I think not. Such a permit might be granted only to persons who are known to be actually engaged in research, and whose *bona fides* is attested.

The question of free alcohol is, you will observe, still unsettled; and I hope that some action will be taken to put an end to such folly. WILLIAM RAMSAY.

Beechcroft, Hazlemere, Bucks.

The Spectra of Helium and Hydrogen.

IT has become a general supposition that the validity of Bohr's theory of the spectra of hydrogen and helium would be definitely proved if certain faint components very close to the hydrogen lines given by Balmer's formula could be found experimentally. On the other hand, if the components were not found after exhaustive search, the theory would be disproved. This supposition is quite incorrect, and in view of the remarkable paper by Mr. E. J. Evans in the current number of the *Philosophical Magazine*, which describes the successful discovery and measurement of these components, it becomes a matter of urgency to indicate at once why such components can give no test of any theory of spectral production.

Into the vexed question of the agent producing the line $\lambda\,4686$, and the Pickering series—whether it be hydrogen or helium—it is not necessary to enter, for the conclusions are the same in either case. We have two alternatives to consider: (1) that the lines are due to helium, and (2) that they are due to hydrogen. Let us, in the first place, take the first alternative, which has been rendered so probable by Fowler in his recent Bakerian lecture. In that case, the line $\lambda\,4686$ belongs to an enhanced line series with 4N as the Rydberg constant instead of N. It is strictly analogous, as Fowler points out, to his new series of magnesium, commencing with $\lambda\,4481$, and we must expect an analogous behaviour. Now no spectroscopist questions to-day the universal validity of the combination principle in spectra, developed by Ritz and Paschen, and some well-defined types of combination series are known. In particular, there is a well-marked spark series in magnesium formed by combinations of the type $3f-mf$, in the usual notation, where nf is the variable part of a line in the "4481" series. In other words, the wave numbers in this series—a comparatively strong one—are differences of the wave numbers of lines in the "4481" series. Fowler has measured seven successive members of this series (Bakerian Lecture, p. 253). If we calculate the corresponding series for helium from the "4686" series, we obtain precisely the Pickering series and the new components measured by Evans. This calculation is independent of *any* theory of the production of series. One series must necessarily be accompanied by the other. In this particular combination, the result is even independent of any expression, empirical or otherwise, of the series by a formula. The difficulty of observing the lines in no way contradicts this necessary origin. They may have another origin in addition, and be really twofold, but since this process must produce them even in the absence of any other, their existence cannot in consequence contribute to the establishment either of Bohr's or of any other theory.

The second alternative is to return to Rydberg's view that half the "4686" series is a principal series of hydrogen, and that the other half is a new principal series. The writer must here insist that he is not expressing a belief in Rydberg's view, though, in his opinion, sufficient justice has not been done to this alternative, which, from the point of view of exact formulæ, is not really inferior to the other, although the need for the presence of helium in the experimental isolation of the lines is against it. The important point is that even if this now somewhat discredited view is correct, the new components near the hydrogen lines must exist, and in *exactly* the same calculated positions as before. They exist again as combination tones, of the type $3P-mP$, where P is now the principal series of hydrogen, and can be calculated at once by subtracting the wave numbers of the "4686" series, or, in fact, of just the half of it which Rydberg designated as the principal series. This combination from the principal series is well known in the alkalis lithium and sodium, just below hydrogen in the periodic table. The lines could only be expected to occur, however, when $\lambda\,4686$ is strong, as in the experiments of Evans.

While, therefore, the isolation of these lines is a great step in the advancement of our knowledge of hydrogen or helium, it cannot prove that they are helium lines, and although they were predicted by Bohr's theory, they were, in fact, previously predicted by the very existence of the "4686" series, whatever its interpretation. While sharing the general admiration for the great simplicity of Bohr's theory as applied to the Pickering and "4686" series, the writer must nevertheless point out the one, and apparently the only, method by which he believes it can be proved or disproved. This is by interference measurements of the first four or five lines in the "4686" series, from which the value of Rydberg's constant can be calculated exactly, and compared with Curtis's value for hydrogen. The lines are not at present measured accurately enough for this purpose.

J. W. NICHOLSON.

University of London, King's College, February 4.

On the History of a Notation in Trigonometry.

THE interpretation of formulas in the trigonometry of plane and spherical triangles is greatly simplified by the expedient of designating the sides by the same letters, respectively, as the angles opposite those sides

—one group of letters being capitals, A, B, C, and the other group small letters, *a*, *b*, *c*. The introduction of this notation is ascribed by Moritz Cantor, in his "Geschichte der Mathematik," vol. iii., 1901, p. 561, to the Swiss mathematician, Leonhard Euler, who first used it in 1753 ("Histoire de l'Académie de Berlin, Année," 1753, p. 231). It is the purpose of this note to point out that this simple, yet important, innovation was made nearly a century earlier.

In the British Museum there is a pamphlet of a dozen small leaves, written in Latin. Upon one side of each leaf there is engraved writing (script). The pamphlet is a collection of formulas for plane and spherical triangles, with drawings. Apparently the process of engraving was resorted to because no type was available for the new symbols used. There is no title-page. The first page contains "Symbola," and, at the bottom, the name "Ri: Rawlinson." The place and date of publication are not given. On one sheet, which is larger than the rest and is folded, there are drawings and time-records to illustrate the passage of the moon over the disc of the sun in an eclipse of January 16, 1655, observed at Oxford. Here the name "Ri: Rawlinson" occurs a second time. Who was this man? It could not be Richard Rawlinson, the antiquarian, for he did not write on mathematics. There is no doubt that the author of the pamphlet is the Rawlingson of whom Anthony A. Wood speaks in his "Fasti Oxonienses," edition P. Bliss, second part, London, 1820, p. 257, placing him in the Oxford list of "Doctors of Divinity" of the year 1661. The reference is as follows: "Sept. 9. Rich. Rallingson or Rawlingson of Queen's coll. chaplain to the duke of Newcastle, was created while the chancellor held the supreme chair in convocation.—He was an ingenious man, well skill'd in the mathematics, but had not preferment confer'd on him equal to his merits. He died in 1668, being then, as I conceive, rector of Pulborough in Sussex."

Thus it appears that the pamphlet was issued between 1655 and 1668. Some of the symbols are the same as those used by Seth Ward, Savilian professor of astronomy at Oxford, in his "Idea trigonometriæ demonstratæ," 1654. All of Ward's symbols were probably originally due to William Oughtred. Ward and Rawlinson used Oughtred's symbols for proportion, A . B : :C . D; they used a slightly modified form of Oughtred's symbols for "maius" and "minus"; they designated by *b'* the complement of an angle *b*. Rawlinson introduced several new symbols. In case of triangles, he designated the sides by the capital letters, A, B, C, and the opposite angles by *a*, *b*, *c*, respectively. This is his most important innovation. The idea of this device was not generally adopted until re-introduced about a century later. Rawlinson went even further. With him, A was the maximum side, C the minimum. Moreover, he distinguished in his notation between plane and spherical triangles by writing the letters in different script. Each letter for spherical triangles was curved in all its parts; each letter for plane triangles had a conspicuous straight line as a part of itself. Rawlinson had symbols for angulus "obliquus," "acutus," "obtusus," "rectus," and "rect. et obl."; he had symbols also for "datum," "latus," "complementum," "compl. com.," "latus op. angu.," "angu. op. lat.," "pars media," "quæsitum," "quadrans," "sinus," "tangens." Rawlinson's symbols for "parallelus," "perpendicu.," "triangulum," "radius" had been introduced into mathematics before 1655, and are still in use at the present time. His pamphlet lays extraordinary emphasis upon the use of symbols. He had what Thomas Hobbes called a "scab of symbols."

During the first half and middle of the seventeenth century British writers introduced symbols into trigonometry to an extent unparalleled by contemporaneous writers in other countries, but our histories of mathematics do not reveal this fact.

FLORIAN CAJORI.

7 Gordon Street, London, W.C.
January 30.

Measurements of Medieval English Femurs.

IN a paper lately contributed by Dr. Alice Lee to *Biometrika* (vol. x., Nos. 2 and 3, November, 1914, p. 208), entitled a "A Table of the Gaussian 'Tail' Functions," the author does me the honour to criticise some statistics which I published in the *Journal of Anatomy and Physiology* (vol. xxxviii., p. 238), on the measurements and proportions of the medieval English femur, derived from the study of bones in the crypt of the Parish Church at Rothwell in Northants.

The criticism, which is undertaken from the point of view of the advanced mathematician, I am ashamed to say I can only partly follow, but it turns largely on the very difficult question of accurate sexing, and Dr. Lee brings forward mathematical reasons for believing that my sexing must be inaccurate.

That this may well be so I readily allow, though I am glad to see that when Dr. Lee has rearranged the sexes to suit mathematical requirements, the average measurements seem to be altered by only the fraction of a millimetre, an amount of no possible importance to the practical anatomist or anthropologist.

There is, however, one method of criticism against which my practical experience in crypts makes me anxious to warn mathematicians; it is the futility of expecting that the measurable bones in a crypt will show any proportion to the number of males, females, and children in the population.

Owing to their greater fragility the children's bones become disintegrated in the course of centuries long before those of adult females; while, for the same reason, those of females do not last as well as those of adult males.

Consequently, when Dr. Lee points out that my method of sexing would mean a predominance of 79 per cent. of males in the population, while hers would give a slight preponderance of females, I submit that my estimate is, in the circumstances, more likely to be in harmony with the proportions of measurable bones in the crypt.

If Dr. Lee could superintend the restacking of a crypt full of bones with a view to their preservation, as I have done on two occasions, she would be astonished at the load of damp bone meal and broken fragments which have to be returned to the churchyard. In this I am sure would be found the excess of female bones as well as most of the bones of the children, thus accounting for the preponderance of male bones left fit for measuring.

F. G. PARSONS.

St. Thomas's Hospital, S.E.

Pheasants and Gun-Firing.

ON December 16, in the morning, pheasants in the woods at Dunsby and Hacconby made the same loud cackling as those later on at Saxby, referred to in NATURE of February 4, p. 622; and keepers made the same remark that there was shooting out at sea. These places are within a few miles of whence I write —viz., Bourne, in Lincolnshire. H. COTTON SMITH.

The Abbey Vicarage, Bourne.

*NOTES ON STELLAR CLASSIFICATION.**
III.

BEARING in mind what has been said about the origin of the special class of bright line stars, I give a diagram showing that they occur exactly where we should expect to find them if the suggested origin is a sound one.

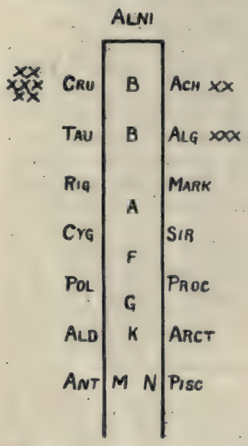

FIG. 5.—Position of the bright line stars at the top of the temperature curve.

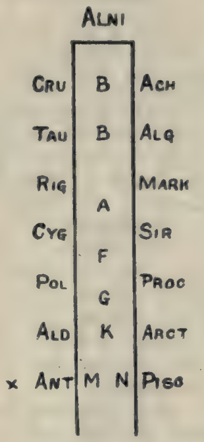

FIG. 6.—Position of the bright line variables at the base of the ascending arm of the temperature curve.

I return to that class of variable stars the changing luminosity of which, according to my hypothesis, is due to the heat and light produced by collisions between meteor swarms (Fig. 6).

Of these stars, in which the bright radiations have been recorded at maximum, one only, *o* Ceti, is included among the eighteen classified at Kensington as Antarian; 225 stars classified as Md (Antarian) are given on the Harvard List.[7] These are chiefly variables of long period. Prof. Pickering has obtained forty photographs showing bright lines, and ten stars have been discovered by means of this peculiarity of the spectrum.[8] Near minimum, when the star is faint, the bright lines are not seen.

There can be no doubt that all are physically similar, and that the position of all is at the base of the ascending arm of the temperature curve. That they are found here and nowhere else is an important test of the view that we have to deal with nebulous clouds consisting of discrete meteorites, as in comets, the gases from which produced by the heat supplied by collisions fill the interspaces at maximum and superadd the bright radiations to the fluting and line absorption seen at all times with varying intensity.

We next pass from these long-period variables with smooth curves, sometimes called "Mira variables," to another class with short periods, and with curves not so smooth, called "Cepheid variables."

The diagram Fig. 7 shows that these occur in the greatest number at a stage higher up the ascending branch of the temperature curve than the Miras. So far bright lines have not been recorded at maximum, but it has been noted that the position of maximum light energy moves towards the violet[9] as the star brightens. Their shorter periods, taken in connection with the fact that they must be more condensed than the Miras judging from their position on the curve, explains this difference of behaviour—there are no interspaces.

The Cepheid variables are not the only class without bright lines. I have already (Bull. I.) referred to the "eclipsing variables." Of these there are two classes, represented by β Lyræ and Algol, in which the shape of the curve is very different. This difference seems to arise from the fact that in the case of the Algols we are dealing with true discs, while in the case of the Lyras this stage has not been yet reached. These conditions are indicated by the position of the Lyras on the ascending and of the Algols on the descending arm of the curve.

Among the Piscian stars at the base of the descending arm we find a number distinguished by their irregular variability. In these we deal with a star rapidly dimming, surrounded by vapours of carbon giving absorption flutings, and of iron giving a multitude of absorption lines. The changes in the density of these vapours, to say nothing of the possible formation of scoriæ, are sufficient to explain the variation and irregularity in the light given out by these bodies. There are no interspaces to produce bright lines.

It is singular that some inquirers seem to regard the Antarian and Piscian stars (M and N) as being similar and so treat them as convertible terms, while the fact is that the only similarity is their temperature. The following table will indicate their dissimilarities:—

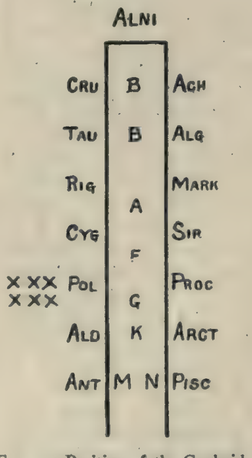

FIG. 7.—Position of the Cepheid variables halfway up the ascending arm of the temperature curve.

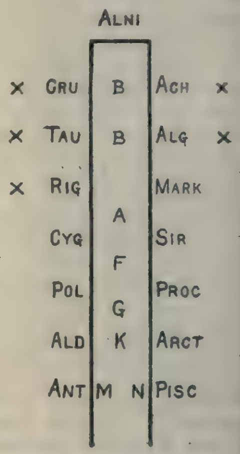

FIG. 8.—Position of the eclipsing variables towards the top of the curve.

Antarian.	*Piscian.*
Least condensed	Most condensed
Titanium absorption flutings	Carbon absorption flutings
Regular variables	Irregular variables
Bright lines	No bright lines

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* Continued from p. 619.

[7] *Annals*, vol. lv., pt. 1.

[8] *Astr. Nachrichten*, vol. clxxxvii., p. 1.

[9] Albrect in *Astrophysical Journal*, xxv., 332.

I have before referred to Miss Maury's *c* and *b* "divisions." It is interesting to see how the stars composing them arrange themselves on the ascending and descending arms. The facts are given in Figs. 9 and 10.

Prof. Ejnar Hertzsprung[10] has discussed the divisions of Miss Maury's classification, and while he finds that there is no systematic relationship between the *a* and *b* divisions with regard to spectral differences and differences of brightness, yet it is otherwise in the case of the *c* and *ac* divisions. The *c* stars, he finds, are very distant, and are extraordinarily bright. According to him (and previously according to Miss Maury) they seem to suggest different physical constitutions from the other divisions, and he terms them "whales," while the other stars he considers as "fishes." In his paper he gives a list of twenty-four *c* and *ac* stars. All of these included in my catalogue, with two exceptions probably due to errors of classification, fall on the ascending arm of the temperature curve (see Fig. 9).

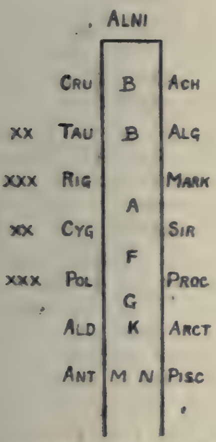

FIG. 9.—Position of the "*c*" stars on the ascending arm.

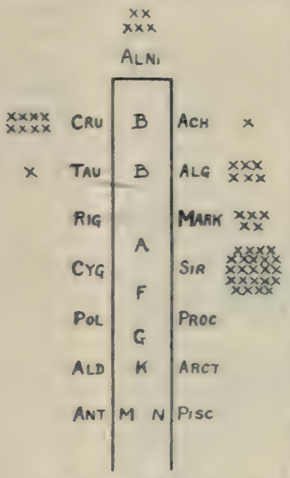

FIG. 10.—Position of the "*b*" stars at the top of the temperature curve and on the descending arm.

They are thus found to be condensing swarms following in a natural sequence the more sparse swarms so rich in variables of the *o* Ceti type.

Their great luminosity is due more to volume than to temperature, and the special characteristics of the lines, as opposed to those of the *a* division, are due to the difference in absorbing conditions in sparse swarms and bodies with forming atmospheres, and also to the fact that the "solar" lines only occur in stars of lower temperature.

The stars of type *"b,"* on the other hand, are seen to arrange themselves in an orderly sequence following on those of type "*c*" (Fig. 10). At the top of the ascending arm, where the sequence of *c* stars ends, the *b* stars come in, and extend round through the top of the curve down to the Sirian stage on the descending side. This sequence of the *b* on the *c* stars is a very suggestive one. As a *c* star approaches its maximum temperature, the physical conditions change from those giving rise to type *c* spectra to those from which spectra of type *b* are produced.

We are now in a position to derive some material results from the preceding considerations. In view of the definite manner in which the physical properties considered have shown themselves to be associated with the various groups on one arm of the curve or the other, we are justified in using these physical properties as criteria for locating stars on the ascending or descending arm of the temperature curve.

In the case of the constant bright line stars, Fig. 5 shows that considerations of their physical conditions may be made under the probability that all these bodies are in the neighbourhood of the maximum temperature attained during their evolution. Thus the twenty-six bright line stars mentioned earlier as being contained in the Harvard lists may be considered as being located on the temperature curve.

On the Harvard scheme, with the exception of classes M and N, stars may belong to either, as increasing and decreasing temperatures are neither recognised nor provided for. In classes M and N, as in my hypothesis, we are dealing with the bottoms of the ascending and descending branches, lowest temperatures and vastly differing conditions are involved. Hence we can classify as Antarian or Piscian all stars designated M or N on the Harvard system. We thus obtain from the Harvard Revised Photometry and the Second Catalogue of Variable Stars, about 650 and 70 of these two classes respectively.

Next, regarding the Cepheid variables, the Harvard Second Catalogue of Variable Stars contains thirty-four short period variables with approximately solar spectra. These are Cepheid variables, and may all be placed on the ascending arm, in conformity with the six already classified.

With regard to the eclipsing variables, those with continuously varying light-curves, like that of β Lyræ, will probably lie on the ascending arm of the temperature curve, and those like Algol may be expected to occur on the descending branch.

Finally we have to deal with the "c" and "b" stars. From the manner in which the ten of Miss Maury's Type "c" stars, which have been classified at Kensington, aggregate on the ascending arm, we may place the remaining nine given in her tables[11] in corresponding positions.

From the same source we find about ninety stars of Type "b." Those classified at Kensington are seen to cluster round the top of the curve, and to extend down the descending arm. Hence, when considering the physical conditions of those not so classified, we may regard them as occupying similar positions.

We are thus able to add nearly 900 stars to the 470 already classified on the temperature basis at Kensington.[12]

NORMAN LOCKYER.

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[10] *Astr. Nachrichten*, vol. clxxix., No. 4296, p. 374.

[11] Annals Harv. Coll. Obs., vol. xxviii., part i.

[12] Catalogue of 470 of the brighter stars.

THE MANUFACTURE OF DYESTUFFS.

In an article in NATURE of January 21, p. 555, the National Dye Scheme put forward by the Board of Trade Advisory Committee on December 22, 1914, was outlined, and in some of its aspects the development of dye manufacture in this country is of such far-reaching national importance that the subject claims the close and continued attention of all men of science. As stated last week (p. 621), the original scheme has now been replaced by modified proposals, the full details of which are not, however, yet available.

The outstanding feature of the new scheme is that the Government has undertaken to make a grant to the new company, for a period of ten years and to a total amount not exceeding 100,000*l.*, for the specific purpose of experimental and laboratory work, this grant being independent of the Government loan of a portion of the working capital of the company. Chemical research has thus officially been recognised and endowed as an essential factor in solving a national industrial problem; and this most important and far-reaching decision has everywhere been favourably received, and represents a permanent advance in public thought and official procedure. Probably the main factor in moving the Government to assist the development of dye manufacture is the fact that one and a half millions of workpeople are more or less dependent upon the continuance of the dyeing industry. While we realise these special claims to attention, we hope at the same time that similar practical steps will at once be taken to promote the development in this country of glass manufacture and other industries dependent for their success upon progressive scientific knowledge.

FIG. 1.—A German coal-tar colour factory.

The new dye company is to have powers to arrange for the assistance of a committee of experts conversant with the dyeing trade and its requirements. In the absence of details of the scheme, it does not appear that this proposal will adequately meet the claim that the technical expert should be largely represented on the directorate.

A perusal of the Press correspondence on the whole matter indicates that opinion has crystallised to some extent into a general agreement that the first aim should be immediately to develop and co-ordinate our existing manufacturing concerns, and encourage an increased output from Switzerland by arranging for the export of raw tar products to that country, and for transport facilities through France. But these expedients can afford only a very partial relief, and stocks of dyes are rapidly disappearing. It is therefore generally recognised as a matter of great urgency that the new manufacturing company should commence operations, and the first act of the company should be to devise an organised scheme of research on the initial problems of processes and yields.

One of the most instructive discussions of the problem facing the manufacturers of coal-tar dyes in competition with Germany is to be found in an address recently delivered by Dr. W. H. Nicholls before the Philadelphia meeting of the American Association for the Advancement of Science, and printed in *Science* for January 8 under the title "The War and Chemical Industry." Dr. Nicholls, speaking with the authority of one who has been for many years at the head of a large chemical organisation in the United States, throws some interesting sidelights on the reason for American inactivity in this field. American manufacturers were at first assured by "one of the large producers in Germany that it was absolutely certain that American coal did not possess the necessary constituents to make it useful as a basis for the production of organic chemicals." When, in spite of this discouragement, it was actually found that aniline oil could be made at a profit in the States, "down went the price below cost. A tariff of 10 per cent. which was put upon the article was immediately absorbed by the foreign makers, and the price became lower still." The result was that the infant industry ceased to exist, and has only come to life again since the outbreak of the war.

It is emphasised that "to take away the dye business from Germany means attacking the best equipped and the best income-producer of Germany's entire chemical and allied industry"—a branch which, in 1912, with a total capital of nearly 8,000,000*l.*, paid a dividend representing 22 per cent. of the capitalisation. The fact that German works have long ago written off the cost of their plant, together with their acquired experience and their sales organisations, largely account for the almost complete control which Germany has acquired in this branch of industry, and these are insuperable difficulties to be met by any competing nation unless really effective State-aid is guaranteed in the future.

The accompanying illustration (Fig. 1) from the *Little Journal,* for December, published by Messrs. A. D. Little, of Boston, Massachusetts, shows a typical German coal-tar colour factory. Some idea of the development of the German dye industry is afforded by the history of the Farbwerke Meister, Lucius und Brüning, which was organised in 1862 by two chemists and two merchants, with a staff of five workmen, one clerk and one chemist, and an engine of three horse-power. In 1912 7680 workmen, 374 foremen, 307 chemists, and 74 other higher technical officials were employed by this single firm, the wages paid out being 8·6 million marks, whilst 5·2 million marks were expended in salaries and bonuses. Eleven thousand different substances were manufactured, and the steam engines had a total horse-power of 30,000.

Closely wrapped up with the question of the manufacture of aniline dyes in Great Britain is that of the future of indigo in India, which is discussed in an article in the *Pioneer Mail* of January 8. It is here emphasised that during the past few years the indigo grown in Bihar and Orissa has been falling off in a remarkable way owing to the competition of the synthetic dye; whereas in 1913 63,100 acres were under indigo, the area grown this year is only 38,500 acres. Owing to the war, however, the price of natural indigo has rushed up enormously to more than 700 rupees per maund, a rise of about 300 per cent. on the normal price of the past three years. Thus the few indigo planters who were still producing indigo have been fortunate enough to make very large profits, and if they can continue or increase their production during 1915 they will be in an equally strong position. It is, however, difficult to estimate the ultimate effect of the war upon the indigo industry of India. There is no doubt that trade with Germany will be suspended for some time to come, and some time must also elapse before the manufacture of the synthetic dye can be established in France or England. Moreover, the use of natural indigo will probably be stimulated, owing to the increased requirements of the War Office and Admiralty, so that for some time to come the indigo planters will probably benefit considerably and make profits which will be some compensation for the lean years recently passed through. But there is little doubt that in the long run the synthetic dye, whether manufactured here or in Germany, will very largely supplant the natural material; it will be a repetition of the history of the madder industry. On this side of the question reference may be made to the lecture delivered recently by Dr. F. M. Perkin before the Society of Arts, and published in the *Journal* for January 1, and to the discussion which this paper evoked.

METALS AND WAR.

CONSIDERABLE attention has recently been devoted to the internal resources of Germany as a producer of various metals, more particularly, of course, of such metals as play an important part in the manufacture of war material. It has been shown that the normal consumption in Germany of copper, for example, is about 250,000 tons yearly, whilst the production is only about 25,000 tons, of which 20,000 tons are produced from one mine alone, the well-known Mansfeld mine, so that the possibility of any great increase in the domestic production would appear to be remote. The bulk of the German copper is imported from the United States, which produces more than half of the world's supply of copper, amounting now to about one million tons per annum, so that in normal times Germany purchases about one half of the United States' output of copper. It is obvious that the American producers of this metal must be seriously affected by the loss of so very important a customer.

Although public interest has centred mainly upon copper in this connection, there are other metals of scarcely less importance in this respect; thus nickel is used in the manufacture of armour plate, of special steel for ordnance and numerous similar purposes, and for some purposes can even be used to replace copper, as in the casing of leaden bullets. Germany produces practically no nickel, but has to import all its requirements; it would appear that the imports of nickel and nickel ore, which latter is smelted in Germany, would represent between 5000 and 6000 tons of nickel, of which about 1500 tons is re-exported, so that the German consumption may be taken as approximately 4000 tons per annum, out of the world's total production of some 28,000 tons. Again, manganese is indispensable in steel manufacture. In round numbers, Germany produces about 85,000 tons of manganese ore, and imports normally 650,000 to 700,000 tons, the bulk of which comes from the Caucasus, so that Germany produces only about one-ninth of its normal requirements of manganese, and the cutting off of the supplies of this substance cannot but seriously affect its steel production.

NOTES.

IN answer to a question as to typhoid in the Army, asked in the House of Commons on February 8, Mr. Tennant, Under-Secretary of State for War, said:—"Of the 421 cases of typhoid in the present campaign among British troops 305 cases were in men who were not inoculated within two years. In the 421 cases there have been thirty-five deaths. Of these deaths thirty-four were men who had not been inoculated within two years. Only one death occurred among patients who were inoculated, and that man had only been inoculated once, instead of the proper number of times—namely, twice." This is a marvellous record; and no further answer than it provides is needed to the inhuman efforts made by anti-vaccinationists to induce men to object to inoculation by which such protection is secured. Replying to some carping criticisms against inoculation made by Mr. Chancellor in the House of Commons on February 9, Dr. Addison pointed out that in the South African war there were 58,000 cases of typhoid—more than an Army Corps—whereas in our great force now in France and Belgium, and after six months, including three months of atrocious weather, there have only been 421 cases among our troops. The total losses in South Africa were 22,000, of which about 14,000 deaths were from diseases and 8000 of these were from typhoid. When we compare this immense sacrifice of human life from preventible disease with the record stated above, we can only wonder at the patience of the British people in permitting a prejudiced faction to urge men not to subject themselves to a treatment by which they save others and themselves from suffering and death.

PROF. G. O. SARS, professor of zoology, University of Christiania, has been elected an honorary member of the Challenger Society.

SIR W. WATSON CHEYNE will deliver the Hunterian oration at the Royal College of Surgeons, Lincoln's Inn Fields, on February 15, taking as his subject "The Treatment of Wounds in War."

DR. SIDNEY COUPLAND has been appointed Harveian orator (of the Royal College of Physicians) for 1915; Dr. J. Michell Clarke Bradshaw lecturer for 1915, and Dr. Samson G. Moore Milroy lecturer for 1916.

THE Secretary of the Admiralty announces that the King has approved the award of the Polar Medal to the officers and men who took part in the Australasian Antarctic Expedition of 1911–14, under the leadership of Sir Douglas Mawson.

IT is announced in the issue of *Science* for January 29 that the city of Philadelphia, acting on the recommendation of the Franklin Institute, Philadelphia, Pa., has awarded the John Scott legacy medal and premium to Dr. C. E. Guillaume, of Sèvres, France, for the invention of his alloy invar.

ACCORDING to the *Southern Times* of February 6 the monument on the grave of the late Dr. Alfred Russel Wallace in the cemetery at Broadstone, Dorset, is a fine specimen of fossil tree from Portland, seven feet in height and weighing some two tons. The specimen stands on a foundation of Purbeck stone, and an inscription on it indicates merely Dr. Wallace's name and dates of birth and death.

DR. W. H. HADOW, principal of Armstrong College, Newcastle-upon-Tyne; and Engineer Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S., Engineer-in-Chief of the Fleet, have been elected members of the Athenæum Club, under the provisions of the rule which empowers the annual election by the committee of three persons "of distinguished eminence in science, literature, the arts, or for public service."

THE death is announced, in his fifty-eighth year, of Prof. L. L. Dyche, of the University of Kansas. He was a graduate of that institution, at which he was appointed in 1885 assistant professor of zoology, in 1886 professor of anatomy, in 1890 professor of zoology, and in 1900 professor of systematic zoology. He had made twenty-three scientific expeditions in various parts of North America, as well as Greenland and the Arctic regions, and had thereby secured for the University of Kansas one of the most valuable collections of mammals in the United States.

DR. BENJAMIN SHARP, who had charge of the department of zoology in Peary's first Arctic expedition, has died at Morehead, North Carolina, at the age of fifty-six. For a time he was professor of invertebrate zoology at the Philadelphia Academy of Natural Sciences, and afterwards at the University of Pennsylvania. He was then appointed corresponding secretary of the former institution, in whose interests he made collecting expeditions to the Caribbee Islands, Hawaii, and elsewhere. He was an industrious lecturer and writer on zoological subjects.

THE occurrence of frost-bitten feet among the troops has been reported from time to time. According to the *Morning Post*, February 5, Dr. Temoin, of Bourges, has investigated the subject, and concludes that the affection is not due to frost-bite, but is a gangrenous condition caused by arrest of the circulation through pressure, cold being a contributing but secondary factor. Wet causes the puttees to contract and retard the circulation, and the feet swell in consequence in the boots, which also somewhat contract. The remedy is to induce the soldiers frequently to take off their boots, and to reduce the period in the trenches.

IN a paper read before the Institution of Civil Engineers on February 9, Mr. F. D. Evans dealt with engineering operations for the prevention of malaria, as carried out in the Federated Malay States. Drainage is all-important, and an inexpensive and thoroughly efficient type of drain has been evolved to meet the conditions, formed of concrete blocks of half-egg shape, laid close but unjointed. The blocks are laid without foundations even on bad ground in flowing water. Should they move out of line or gradient, it is easy to re-set them correctly when the surrounding ground has settled, after which they give no trouble; but re-setting is rarely necessary.

A FEW weeks ago it was reported by cable that Sir Ernest Shackleton would not reach the base from which he intends to start his crossing of the Antarctic continent, in the Weddell Sea, in time to proceed this season. Letters and a diary now published in the *Daily Chronicle* confirm this. The ice has been very late in breaking. Sir Ernest now hopes to get away from the base at the beginning of November next, after wintering there. His present communications have come from South Georgia, and an interesting and useful piece of scientific work has already been done there in the erection of true meridian posts, which will enable whaling and other ships to test their compasses. The voyage to South Georgia appears to have been prosperous, and the expedition has received an addition to its *personnel*, which must be unusual for a polar voyage, in the shape of a stowaway.

The Calcutta correspondent of the *Morning Post*, in a communication dated January 7, states that the trustees of the Indian Museum, Calcutta, have addressed to the Government of India the following protest against the acts of vandalism perpetrated by the Germans in destroying Belgian museums and buildings of historical interest: "We, the office bearers of the Board of Trustees of the Indian Museum, desire to protest on behalf of our Board against the unnecessary destruction of libraries, art galleries, museums, and buildings of purely historical and artistic value in time of war. We do so with the knowledge that we have the support of our colleagues in other countries and with the conviction that the collective opinion of the governing bodies of scientific and artistic institutions throughout the world should be regarded as a matter of international importance, and that, on the conclusion of the present war, steps should be taken to lay down definite rules under international sanction for the preservation of artistic, historical, and scientific treasures during warfare."

The North-East Coast Institution of Engineers and Shipbuilders has conferred its honorary membership upon Lord Fisher, First Sea Lord, in recognition of the part taken by him in bringing about the reform of the position of the rank and status of the naval engineer officer. In asking Lord Fisher to accept this honour the institution wrote: "It was with special satisfaction and pride that the council of this institution learned of the Admiralty order of the 24th December conferring military rank upon the 'old entry' engineer officers of the Royal Navy—satisfaction, in that it is believed that the change will lead to increased naval efficiency; pride, in the realisation of the fact that their professional brothers have won so honourable a recognition of their value in the constitution of 'our sure shield' the Navy. Our institution is convinced that it is chiefly to your lordship's keen perception of the dominating importance of engineering science and *matériel* in the constitution of the modern Navy that the nation is indebted for this wise and generous readjustment of the rank and status of naval engineer officers."

The explosives industry has experienced a severe loss in the death of Capt. M. B. Lloyd, late of the Royal Artillery, and for the last seven years a director of the well-known firm of Messrs. Curtis's and Harvey. Born in 1865, Capt. Lloyd entered the Army from the Royal Military Academy in 1884, and in 1896 passed first out of the advanced class of the Ordnance College, obtaining the Lefroy gold medal and "honours" in practically every subject, including mathematics—a very rare distinction. On the death of Sir Vivian Majendie in 1898 he was appointed an inspector of explosives at the Home Office, and for a year or more was in charge of the recently established testing station for mining explosives on Plumstead marshes, where he did a considerable amount of useful work in connection with the risks due to the presence of gas and dust in coal mines, the experience he thus gained proving most valuable when he was subsequently appointed secretary of the Departmental Committee on "bobbinite." After leaving the Home Office early in 1908, and joining the directorate of Messrs. Curtis's and Harvey, Capt. Lloyd's exceptional qualifications led to his services being much in demand on technical committees; he was selected to represent the explosives trade on the War Office Committee on the Shipment of Explosives, on the Departmental Committee on the Heat Test, and on an informal committee appointed to consider the best form of construction for "danger buildings," and was made a member of the Home Office Committee on celluloid and its dangers. His premature death will cause a gap difficult to fill.

In his paper on the "Fortified Headlands and Castles on the South Coast of Munster," reprinted from vol. xxxii., 1914, of the Proceedings of the Royal Irish Academy, Mr. T. J. Westropp has discovered an almost unexplored field in Irish archæology. These Irish coastal forts were constructed at various epochs. In some, like Howth, near Dublin, and Shanoan in Waterford, flint instruments have been discovered; some belong to the Bronze Age; others, again, were built or occupied by Danes, Welsh, or Normans. They differ greatly in form, and the following types are recognisable: simple headland forts with a single wall; complex, with several earthworks or walls; entrenchments or citadels; multiple forts with a single wall; complex, with several earthwith a gangway natural or artificial; headlands with a deep natural hollow at the neck; and fortified shore-rocks, usually isolated at high water. This interesting paper is well illustrated with photographs and ground plans. The completion of this investigation along the other parts of the Irish coasts, for which materials are now available, will be welcome.

In the latest issue of the Anthropological Publications of the University of Pennsylvania (No. 1, vol. vi., 1914) Dr. G. G. Maccurdy has given an account of a collection of twenty-four skulls of the natives of the eastern end of New Britain—or, as the Germans have renamed the island, Neu Pommern. The natives of this island have heads which are very narrowly compressed from side to side, but in their general feature are clearly close relatives of the Australian aborigines. Dr. Maccurdy finds their canial capacity to be very low, the average for male skulls being 1345 c.c., for female skulls 1214 c.c. Apparently such an estimate depends on the material used in filling the cranial cavity, for Dr. Krause, employing millet as a measuring medium, in place of the shot used by Dr. Maccurdy, found the cranial capacity to be much lower for the natives of New Britain, viz., 1267 c.c. for males and 1180 c.c. for females. Dr. Maccurdy directs attention to a remarkable observation which Virchow made on three skulls from a common grave in New Britain. One was that of a man with a capacity of 2100 c.c., the other of a woman with a capacity of only 860 c.c. Virchow explained the difference as being due to the fact that the man had suffered from hydrocephaly, while the woman had been a subject of imbecility. It would be very interesting to know if the great pathologist's explanation was really the true one—or if such a variation of brain capacity does occur among normal individuals of a native and untutored race.

The *Journal of Anatomy and Physiology* for January, 1915, contains a paper by Dr. R. J. Gladstone and Mr. Erichsen-Powell on manifestations of occipital vertebræ and fusion of the atlas with the occipital bone in man. Four specimens of this variation are described, and its causes are discussed. Speaking generally, variation about a mean, with compensatory changes in other regions of the body, may be regarded as an established biological principle, which governs or acts on this region, as well as on growth and development in general. The authors are inclined to regard the majority of the variations in the occipito-atlantal region as largely attributable to this cause.

Messrs. F. Davidson and Co., of 29 Great Portland Street, W., have sent us a descriptive pamphlet of the "Davon" super-microscope. The idea of this instrument was suggested by the principle governing the micro-telescope (described by Prof. Boys in Nature, January 22, 1914), which is that of providing the microscope with an image *in air* of a distant object, the air-image being magnified by the microscope. This is accomplished by attaching a tube carrying a stage and focussing screw to the condenser-fitting under the stage of the microscope. The primary microscope slides into this tube, and consists of a tube with stops and an eyepiece and an inner tube, also stopped, carrying the micro-objective; this performs the primary magnification of the object and the image formed by the combination in air anterior to the eyepiece is then magnified by the microscope, to which it is attached, which is termed the "secondary" In this way almost unlimited magnification can be obtained, though, of course, resolution is unaffected thereby. For photomicrography no long-extension camera is required by this arrangement.

A recently published number of the *Annals of Tropical Medicine and Parasitology* (vol. viii., No. 3) contains a memoir on sleeping sickness in the Eket district of Nigeria, by Drs. Macfie and Gallagher. An endemic focus of sleeping sickness of considerable magnitude was found in this district, but the disease is of a mild type, occurring chiefly in children; the mortality is low, and spontaneous cures appear to be frequent. The trypanosomes can be found in the juice of the lymphatic glands, but have not been detected in the peripheral blood; the parasites differ in some respects, both in their morphology and pathogenic reactions, from the typical *Trypanosoma gambiense*, and the authors regard them as a distinct species (*T. nigeriense*, Macfie), characterised morphologically by the occurrence of a small percentage of peculiar diminutive stumpy forms. The infection is believed to be carried by *Glossina tachinoides*. The memoir is well illustrated, and in an appendix by Dr. Macfie it is shown that *T. pecaudi*, *T. pecorum*, and *T. vivax* are transmitted also by *G. tachinoides* in the Eket district. In another memoir in the same publication Dr. Macfie describes various blood-parasites collected by him in Nigeria. Amongst these are some organisms found in the blood of guinea-pigs and resembling the organism described by Seidelin from human blood under the name *Paraplasma flavigenum*, which is alleged to be the parasite causing yellow fever.

According to a recent "count," as recorded in the *American Museum Journal* for January, the total number of fur-seals on the Pribilow Islands (where slaughter is now prohibited) in 1913 was 268,305—a large increase in the matter of "pups" over the preceding year.

In the *Victorian Naturalist* for December last Mr. J. A. Kershaw, curator of the Melbourne Museum, recounts his experiences during a collecting trip to the Claudie River district, in the north of the Cape York Peninsula, Queensland. One of the incidents was a brief sojourn on Lloyd Island, where the party was much interested in the swarms of nutmeg-pigeons, Blue Mountain parrots, and shining starlings, which resort every evening to the island to roost, and return at early dawn to pass the day on the mainland.

Mr. J. R. Henderson's administration report of the Madras Museum and Aquarium for the financial year 1913–14 has been issued by the Educational Department for that Presidency. A feature of the year's work was formed by demonstrations in the museum given to local schoolboys; another series of demonstrations being also arranged for teachers. Specimens of three newly described Indian mammals were presented to the museum by the Bombay Natural History Society. The Marine Aquarium maintained its popularity, more than four thousand rupees being taken at the toll-gates. A slime-head (Ophiocephalus) and a ray (Trygon) bred during the year in the central fountain.

We are indebted to the author, Mr. J. A. Hutton, for a copy of a report on salmon-netting in the Wye during 1914, reprinted from the December issue of the *Salmon and Trout Magazine*. There were expectations that the season's catch would be exceptionally good, but it proved very disappointing, the total number of fish being only 2842, as compared with 6408 in 1913. The catch was, in fact, the smallest taken since 1908. Since the resumption, after a three years' interlude of netting in 1905, there have been great fluctuations in the number of salmon annually netted in the Wye. During the first four seasons the take averaged 2330; in 1909 there was a rise to 4319, while in the next three seasons the average fell to 3304, to be succeeded, as already mentioned, by an unprecedented increase to 6408 in 1913.

With the assistance of the Imperial Institute efforts are being made to create a market in the United Kingdom for the ground nuts grown in India and West Africa and their products—oil and feeding-cake. The export of ground nuts combined amounted to more than seven million cwts. in 1912, of the value of nearly 4,000,000*l.*, and hitherto France and Germany have between them absorbed the greater part of this supply. The cessation of trade with Germany, and the diminution of the French demand, placed Indian producers in a serious position, and though recently the mills at Marseilles have placed orders with India, the demand from France remains below the normal. A quantity of the nuts has recently been imported into Hull from India for the production of ground nut oil, which is suitable for use as an edible oil as well as for soap-making. Abundant supplies are available from India, and when all foodstuffs are rising in price it is important to remember that ground nuts yield not only oil and feeding-cake, but are also valuable for edible purposes. In the United States they sell as roasted peanuts, and in the form of "peanut butter." Blanched kernels are regularly used in West Africa as a vegetable, mostly in the form of ground nut soup, but there are a variety of other ways in which ground nuts, which are both palatable and highly nutritious, can be prepared for the table.

IN Bulletin No. 10 issued by the Agricultural Department of the Armstrong College, Newcastle-upon-Tyne, Prof. Gilchrist records the results of rotation experiments made at Peepy in 1910-13, and brings out a point of special interest to both the farmer and the man of science. Three plots received farmyard manure stored for different times at the rate of 12 tons per acre. The various forms of dung were: (1) fresh; (2) dung kept just long enough to be in good condition for application; and (3) old dung stored in a heap for some months. The best return from the four crops of the rotation was given by the manure kept for a short time only before it was applied. The old manure gave a rather better return than the fresh dung. The effect of the different dungs was naturally shown most clearly by the swedes, the first crop of the rotation, on which the dung kept for a short time only (2) showed a gain per acre 65 per cent. better than the old dung (3). This striking difference may be attributed to the heavy loss of readily available nitrogen and phosphate which occurs in farmyard manure when stored in heaps exposed to the weather. Recent laboratory experiments by Löhnis and Hunter Smith showed that fresh dung stored for periods varying from one to twelve weeks and then mixed with soil, subsequently nitrified at very different rates. As the optimum period of storage indicated by these workers was four weeks, it would be interesting to know exactly how long the manure used in Prof. Gilchrist's most successful experiment was kept before application to the plot.

THE Monthly Weather Report issued by the Meteorological Office for December, 1914, is of more than ordinary interest, due to its reference to rain, floods, and gales. The frequent and abundant precipitation in many parts of England is said to be without a December precedent. The effects were the more marked because it followed a wet November, resembling the wet spells in 1876 and 1911. Many gales occurred during the month, and some were of great violence, whilst the atmospheric pressure was lower on the whole than in any December since 1876. December 23 and 24 were the only days when the pressure distribution over the country was not cyclonic. Temperature was generally above the normal until December 18, but afterwards it was generally below the normal. The rainfall exceeded the average in all parts of the kingdom, whilst the excess was abnormal over a large area in England. At Kew Observatory the total is quoted as 6·37 in., and was the highest December value since the record began fifty-nine years ago. At Greenwich Observatory the total was 5·96 in., and was the highest December value in the last one hundred years. It is mentioned that at many stations the percentage exceeded 300, the most notable being along the south coast of England and in the Isle of Wight. The highest values given are 331 per cent. of the average at Worthing, 354 per cent. at Totland Bay, and 415 per cent. at Hawarden Bridge. An aurora was observed at Newton Rigg on December 26.

IN *L'Elettrotecnica* for October 5, 1914, Lo Surdo gives a complete review of the work done by J. Stark and himself on the electrical analogue of the Zeeman effect, *i.e.* the splitting up of the hydrogen lines of the spectrum by the intense electric field in the Crookes dark space. A brief account of Lo Surdo's experiments was given in NATURE for May 14, 1914 (vol. xciii., p. 280). Making use of Stark's observation that the separation of the components is proportional to the field strength, the author now seeks to determine the distribution of the field in the dark space. If the discharge tube is parallel to the collimator slit, it is found that the red hydrogen line is transformed into a Y-shaped figure, the upper end of which corresponds to the space nearest the kathode. It is, therefore, concluded that the field intensity decreases more or less uniformly with the distance from the kathode. This agrees roughly with Schuster's direct measurements, but is altogether opposed to those of Graham, who found points of maximum and minimum intensity. It may be remarked that the author appears to be unacquainted with the excellent measurements of Aston on the same subject.

RECENT publications of the U.S. Coast and Geodetic Survey include the results for 1911 and 1912 from the magnetic observatory at Vieques, Porto Rico, and the annual report on field magnetic work for 1913. The former publication, in addition to diurnal variations of the magnetic elements relating to local mean time derived from the ten quietest days of the month, now contains diurnal variations relating to Greenwich mean time for the five international quiet days. As usual, there is a list of disturbed days on the scale 1 to 4 (highest disturbance). 1912 was exceptionally quiet, only one day reaching standard 2, and none standards 3 and 4. An interesting but somewhat disquieting statement is that, owing mainly to error respecting the "distribution constant" for the deflecting and deflected magnets, a correction of 10 per cent. is required to the previously accepted scale values for the Eschenhagen vertical force magnetograph. Of the field observations, perhaps the most interesting are from a number of closely adjacent stations in two disturbed areas, one the crater of Kilauea, in Hawaii, the other near Wilmington, in Delaware. Large variations were observed in each case, especially in declination. The Survey, it seems, has decided that, beginning with 1913, all the results of magnetic observations will be referred to the "International Standard of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington." This entails a reduction of one-tenth per cent. in the values of horizontal force previously published. An interesting question of the near future promises to be what this "international standard" really means, and how it is to be maintained constant.

In view of the recent report to the Board of Agriculture on the possibility of reviving the flax industry in Great Britain, a paper on the field and industrial retting of the fibre read before the Société d'Encouragement de l'Industrie Nationale (*Bulletin*, vol. cxxi., p. 153) by M. Albert Durand, the general secretary of the Comité Linier of France, has especial interest. An account is given in this paper of the different methods of retting of flax now used in France, as well as of the new mechanical and biochemical processes which have been the subject of trials on the large scale. It is interesting to note that M. Durand considers the policy of inaugurating central retting establishments, which was proposed in the report to the Development Commission, as one that could be adopted with advantage in France. The account given of the recent processes of Feuillette and Peufaillet for retting flax, illustrated as it is by numerous photographs, is a special feature of the paper.

Science Progress for January contains a vigorous editorial article on militarism and party politics, a criticism by Dr. H. G. Plimmer of Mr. T. A Cook's recent work on the "Curves of Life," and a survey of the problem of vitalism by Mr. Hugh Elliot. Mr. Rhys Jenkins contributes an interesting article on the international struggle for manufactures as illustrated by the history of the alum trade, Mr. Allan Ferguson gives a summary of recent work on capillary constants and their measurement, and Dr. J. N. Pring reviews the question of the formation of ozone in the upper atmosphere and its influence on the optical properties of the sky. Dr. Edridge-Green deals with colour vision and colour vision theories, a subject which at the present time "is in a state of chaos," and Mr. C. E. Wallis gives an interesting comparison of ancient and modern dentistry.

Engineering for January 15 contains an article on the balancing of high-speed machinery by Messrs. H. D. Wheeler and R. V. Southwell. After giving a clear account of the nature of the problem, the authors describe their optical arrangement in use at Messrs. Lawrence Scott and Company's works for the accurate balancing of high-speed armatures. The armature is supported in ball bearings which can move in a horizontal direction at right angles to the shaft against the action of springs which normally keep the bearings central. The armature is driven by a narrow strap which runs vertically on to and off the armature. At a certain speed depending on the size of the armature and the strength of the springs, the two bearings begin to oscillate in the same direction, showing that one side is heavier than the other. At a higher speed generally about double the former, the bearings again oscillate but now in opposite directions, showing a want of dynamic balance. By means of a circular disc with an involute slot in it, fixed on one end of the shaft, light from the vertical filament of a lamp placed under the bearing is focussed on a screen after reflection at a small mirror which rocks about a vertical axis as the bearings move. By means of the curve traced by the spot of light the proper positions of the balance weights can be found more quickly and more accurately than by the "chalk mark" method.

OUR ASTRONOMICAL COLUMN.

The Red Region in the Spectra of Wolf-Rayet Stars.—In the *Comptes rendus* for January 25 (vol. clx., p. 124) a note is presented by M. J. Bosler on an investigation which he has carried out at the Meudon Observatory on the study of the red region of the spectra of Wolf-Rayet stars. The advance in the magnitude and efficiency of astronomical equipment renders a more minute study of the spectra of faint stars possible, and the bathing of photographic plates opens up new regions of the spectrum for close inspection. M. Bosler describes here the result of the work on fifteen Wolf-Rayet stars, seventy-five clichés in all having been obtained with exposures varying from two to three and a half hours. In the communication he gives a short table, reproduced below, showing the wave-lengths and intensities of several of the lines in the spectra of these stars, which he considers are of more special interest. In the brief discussion he refers to the spectra of novæ and their points of semblance with these bright-line stars, and is led to the view that the Wolf-Rayet stars are only the enfeebled remains of novæ which have appeared in the course of past centuries. The following table embodies the data in five of the stars mentioned above, the figures in brackets indicating the intensities of the lines:—

B.D. 3821+39° Mag. 7·1 (7 plates): 711 (3) 691 (2) 6675 (2) 6563 (5Hα) 643 (2) 6395 (2) 624 (1).
B.D. 4001 +35° Mag. 8·5 (6 plates): 711 (2) 691 (2) 677 (2) 6678 (3) 6563 (5Hα) 643 (1) 6395 (1).
B.D. 4013+35° Mag. 8·0 (8 plates): 6718 (3) 664 (?) 657 (5Hα) 6425 (2) 6300 (1) 624 (?).
B.D. 3639+30° Mag. 9·5 (8 plates): 6717 (2) 6570 (20Hα) 630 (?).
B.D. 3571+43° Mag. 7·5 (1 plate): 6715 (1) 6563 (5Hα) 642 (2).

Aid to Astronomical Research.—In a communication to *Science* (vol. xli., No. 1046, January 15, 1915) Prof. E. C. Pickering directs attention to the great success of research funds, and points out the large returns which can be obtained from relatively small grants to suitable persons. Believing that the greatest return in astronomical output can be obtained by moderate grants to leading astronomers, he has addressed a letter to twelve American astronomers asking them to make a statement showing how they would apply a grant supposing it consisted of one thousand dollars a year for five years. In the communication in question Prof. Pickering publishes the replies he has received, and all without exception would welcome such a grant. An unexpected result of the request was that in nearly every case the principal need proved to be for assistants. The question now arises whether the money can be obtained, but if all cannot be secured, Prof. Pickering suggests that astronomers with fewer assistants should receive precedence. In some cases it is hoped that those interested in a particular observatory may be willing to supply its needs.

THE SPECTRUM OF LIGHTNING.—It is not very often that a very successful photograph of the spectrum of lightning is obtained, but that secured by Mr. A. Steadworthy, and reproduced in the Journal of the Royal Astronomical Society of Canada (September–October, 1914) is of this nature. The easiest way to secure such photographs is by placing a prism or a transparent replica grating in front of the camera lens. In the case of the former the spectrum only is photographed, but in that of the latter images of both the flash and the spectrum are recorded side by side. Mr. Steadworthy employed the first method, using a 60° dense flint glass prism in front of a 2-in. lens of 16-in. focus. The account is accompanied by the measurements of the lines of the spectrum made by Mr. J. B. Cannon, of the Ottawa Dominion Observatory. The wave-lengths of fifty lines are given, and a comparison table is given containing the wave-lengths of the lines measured in the fine spectrum obtained and described by Mr. Fox in the *Astrophysical Journal* (vol. xviii., p. 295). Mr. Steadworthy also secured ten excellent stereoscopic photographs of lightning flashes, some of which are reproduced in his article.

REPORT OF THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY.—The director of the Astrophysical Observatory of the Smithsonian Institution, Prof. C. G. Abbot, has issued his report for the year ending June, 1914. This report contains a brief statement of the equipment of the observatory, the work of the observatory at Washington, and at Mount Wilson. It is shown that progress has been made in the measurement of the effects produced by atmospheric water-vapour on solar and terrestrial radiation. New apparatus for measuring sky radiation has been devised and perfected. A most interesting account is given, including an illustration, of special pyrheliometers for recording solar radiation at great altitudes when attached to free balloons. The highest elevation at which a radiation record has been obtained was about 14,000 metres, or nearly 45,000 ft. The results obtained tend to confirm the adopted value of the solar constant of radiation. A Tower telescope has been erected and put into operation on Mount Wilson. The tower is 50 ft. high and equipped temporarily with a reflecting telescope of 12-in. aperture and 75 ft. focal length. By means of it the variability of the sun has been independently confirmed, and it is stated that changes of the distribution of radiation over the sun's disc occur in correlation with the changes of the sun's total radiation.

ORNITHOLOGICAL NOTES.

IN the report of the council of the Royal Society for the Protection of Birds, embodied in the winter number of *Bird Notes and News*, it is stated that four British lighthouses have now been fitted with bird-perches. The same issue also contains the results of the 1914 competitions for school challenge shields in connection with "bird-and-tree day." Despite a good series of essays from Woburn, the Bedfordshire shield has been withdrawn, on account of the lack of competitors; Lancashire, on the other hand, bids fair to receive the award of a shield during the current year.

In an article on the probable effect of the war in the western area on birds, in *La Nature* for January 16, Dr. E. L. Trouessart expresses the opinion that storks in Alsace and local ground-birds and partial migrants throughout the area of conflict will be the main sufferers. Night-flying migrants, on the other hand, will probably steer clear of the chief areas of conflict, which, looking at the subject in a wide sense, are relatively small. In the neighbourhood of Arras the country was reported to be the resort of myriads of crows in December, attracted doubtless by the rich supply of food.

Among the more notable birds observed in Hertfordshire in 1913, Mr. W. Bickerton records, in the Transactions of the Hertfordshire Natural History Society for January, quail, snipe, and goldcrests as breeding in the county, together with casual visits of the oriole, hobby, and dotterel.

In anticipation of a fuller notice in a forthcoming issue of his *Birds of Australia*, Mr. G. M. Mathews revises the classification of the frigate-birds in vol. ii., No. 6, of the *Austral Avian Record*. Hitherto only two species of these birds have been recognised, *Fregata aquila* and *F. ariel*, the former a widely spread type, split up by some ornithologists into three or four local forms. Mr. Mathews, on the other hand, restricts *F. aquila* to the Ascension Island bird, both sexes of which are wholly black, with no rust-colour on the white heads of the young. The other frigate-birds hitherto classed with *F. aquila* are for the most part identified with *F. minor*, of Gmelin, the typical locality of which is taken to be Jamaica, several subspecies, from the Seychelles, Aldabra, Laysan, the Galapagos, etc., being recognised. The frigate-bird of Christmas Island, Indian Ocean, is described as a new species, with the name of *F. andrewsi*, and is characterised by the under-parts being wholly white in the female and partially so in the male. Lastly, we have *F. ariel*, typically from Torres Strait, characterised by the presence of a white patch on the flanks of the cock, and of which three local races are recognised.

Hybridism in cockatoos forms the subject of an article (illustrated by a coloured plate) by Dr. E. Warren in vol. iii., pt. 1, of the Annals of the Natal Museum, dated September, 1914. A male of the sulphur-crested *Cacatua galerita*, and a female of the slender-beaked *Licmetis nasica*, have been kept for the last eight years or so in a state of semi-confinement in the open air at Pietermaritzburg. During the latter portion of that period the female laid several eggs, two of which were duly hatched. The two hybrids, which are practically similar to one another, are to a great extent intermediate in coloration and plumage between their parents, although nearer to the sulphur-crest than to the slender-beaked species, the resemblance to the former being especially shown by the stoutness and blackness of the beak, as well as by the red loreal patch of the female parent being replaced by orange, and by the total disappearance of the red at the bases of the feathers behind the eyes, so characteristic of the latter. Whether this resemblance of the hybrids to their male parent is due to prepotency in the latter, and the bearing of the whole case on Mendelism, form the subject of a long discussion by the author.

In reference to a recent discussion with regard to birds travelling northwards in autumn on the British coasts, Mr. J. H. Gurney records in the *Zoologist* for December, 1914, that an immense series of flocks of various species were seen flying northwards on October 7 over Cromer, Northreps, and Overstrand, the wind at the time being north. Mr. Gurney is of opinion that such movements are annual, and that after a short interval the wanderers would return south.

During a trip to eastern Siberia in the summer of 1914 Miss Maud Haviland was fortunate enough to come across the curlew-sandpiper breeding at Golchica, at the mouth of the Yenisei. Eggs of this species, it may be recalled, were collected by Mr. H. L. Popham, in July, 1897, on the Kristovski Islands, which are a considerable distance further down the estuary.

According to a narrative published in the January number of *British Birds,* Miss Haviland found the species comparatively abundant in the Golchica district, and procured several skins, as well as a clutch of eggs and a couple of young birds. The last are very similar to young dunlin, but even when a few days old may be distinguished by the shape of the beak. As soon as hatched they leave the dry upland slopes for the sphagnum-bogs that occupy the hollows in the tundra.

R. L.

CLAY AND POTTERY INDUSTRIES.[1]

IN an interesting and valuable introduction, Mr. Graham Balfour, who has been for so many years closely associated with educational work in North Staffordshire, says:—"This volume of collected papers is the first fruits of the Stoke-on-Trent Pottery School, and will in due course . . . be followed by many successors of equal size and value."

The publication of this record of work done by the students and members of the staff coincides with the opening of the New Central Schools of Science and Technology at Stoke-on-Trent, which contain finely equipped chemical, physical, and pottery laboratories and class rooms, and in which the old pottery school finds at last a suitable home.

The school has been conducted by Dr. Mellor for some ten years under conditions which would certainly have damped the ardour of any ordinary man, but this record of work accomplished during these years by Dr. Mellor and his students is a striking testimony to the enthusiasm and ability with which the work has been carried on. It is no longer necessary or desirable that an English pottery student should go to Charlottenburg for his training as a ceramic chemist, for here at hand he has a splendidly equipped school, which has already built up a tradition for research work of the highest importance. The subjects dealt with cover a very large field, but nearly all are of direct practical value to the potter.

Paper xxix. on studies on cylinder grinding is a most excellent contribution, and is a typical example of the thoroughness with which the subjects are treated in their theoretical and practical aspects.

Paper xxiv., on the absorption and dissolution of gases by silicates, by Mr. Bernard Moore and Dr. Mellor, is an extremely interesting and important paper of direct practical value, and the publication of this and other similar work has already beneficially affected pottery practice in this country.

The papers on the nomenclature of silicates and on the chemical constitution of the kaolinite molecule are in another category, but although they are not of direct practical application, they are of great interest to the ceramic chemist, and they show that the outlook of the school is comprehensive and that the work done has an importance beyond the confines of the pottery industry.

The illustrations and descriptions of apparatus—much of which is here described for the first time—are excellent, and it need scarcely be said that Dr. Mellor has used his mathematical ingenuity to advantage in working out and in explaining the problems dealt with. The references to original papers and other published work of German, French, American, and English chemists is a very useful feature of the book.

The papers are naturally of very different values, and their publication in one volume produces a rather uneven "Mosaic" effect, but the impression one gathers from a perusal of the book is the wide scope and thoroughness of the work and its practical value. It is a unique publication in this country as a record of work done by so small a school and in so modest a way.

JOSEPH BURTON.

THE IRISH TECHNICAL INSTRUCTION ASSOCIATION.

THE proceedings of the Annual Congress of the above Association, held at Killarney in May last, are of more than usual interest. The operations of the association cover virtually the whole of Ireland, and the congress just held is the thirteenth since the Act of 1902. Without any question these congresses have contributed largely to the development of scientific and technical instruction in Ireland, and incidentally to a keener interest in a more efficient elementary and intermediate education.

The subjects dealt with have been concerned mainly with industrial progress and with the conditions and problems which await investigation and solution in order to ensure a stable advance in the agricultural, industrial, and commercial well-being of the nation.

In this endeavour there is the closest co-operation on the part of the Government and other official authorities with the education committees of the various areas, and four of the papers of high importance, dealing with the "Problem of Small Industries," "The Technical Training of Skilled and Unskilled Workers in France and Germany," "An Industrial Survey of Ireland," and "Technical Instruction for Small Holders," were read by officials of the Department of Agriculture and Technical Instruction, and Mr. T. P. Gill, the secretary of the Department, gave an inspiriting review of the progress of technical instruction in Ireland since its initiation in 1902.

The position and future of the Irish woollen trade was the subject of a highly interesting paper by Mr. J. F. Crowley, of Siemens Bros., Ltd., with the object of showing that the industry, now somewhat languishing, is peculiarly suited to the genius, temperament, and circumstances of the Irish people, and that, given the organisation, both industrial and commercial, due technical training and capital, there is no reason why the industry should not take a high place amongst the productive enterprises of Ireland. It is essential to its success that there should be, amongst other measures, a central woollen textile school established in the south of Ireland for the efficient training of the various grades of persons engaged in the industry.

The paper by Mr. Macartney-Filgate, well illustrated by maps, diagrams, and lantern slides, setting forth the varied industries and natural resources of Ireland and suggesting lines and methods of scientific development, was of much interest. Whilst the available coal supply is limited, there is water power available, easy of transformation into electrical energy, to the extent of 1½ million horse power, together with an almost unlimited supply of peat fuel, and examples were given showing how this and the former source of power had been successfully utilised on a large scale, and only needed capital and enterprise still further to develop it. The extraction of oil from shale on a considerable scale has also been successfully begun, rendering it possible to utilise the internal combustion engine for the service of the small manufacturer. Much valuable information was given by Mr. L. J. Humphreys on the efficiency of co-operative effort in his paper on "Technical Instruction for Small

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[1] "Clay and Pottery Industries." Being vol. i. of the Collected Papers from the County Pottery Laboratory, Staffordshire. By several Authors. Edited by Dr. J. W. Mellor. Pp. xvii+411. (London: C. Griffin and Co., Ltd., 1914.) Price 15*s.* net.

Holders," illustrated by successful experiments on farms of large extent in Essex and Kent.

The deliberations of the congress reveal the necessity of greater efficiency in the sphere of elementary education, so as to ensure the attendance of all children at school until fourteen years of age and of part time education until at least the age of seventeen.

J. H. REYNOLDS.

FORTHCOMING BOOKS OF SCIENCE.

ANTHROPOLOGY AND ARCHÆOLOGY.

Cassell and Co., Ltd.—Woman's Mysteries of a Primitive People, D. A. Talbot, illustrated. *Macmillan and Co., Ltd.*—General Index to "The Golden Bough: A Study in Magic and Religion," Sir J. G. Frazer; Ancient Hunters and their Modern Representatives, Prof. W. J. Sollas, second edition, illustrated.

BIOLOGY.

Félix Alcan (Paris).—Evolution des Plantes, N. Bernard; Théorie de la Contre-Evolution, Dr. Larger. *A. and C. Black.*—The Story of Plant Life, Rev. C. A. Hall, illustrated; Visual Botany, A. Nightingale, illustrated. *Cassell and Co., Ltd.*—Wonders of Wild Nature, R. Kearton, illustrated; The Book of Hardy Flowers, H. H. Thomas, illustrated. *Chapman and Hall, Ltd.*—Elements of Forestry, Profs. F. F. Moon and N. C. Brown, illustrated. *J. and A. Churchill.*—Plant Life in the British Isles, A. R. Horwood, vol. iii., completing the work, illustrated. *Duckworth and Co.*—A Glossary of Botanic Terms, B. Daydon Jackson, new edition; Birds and Man, W. H. Hudson, new and enlarged edition. *Hutchinson and Co.*—Insect Artisans and their Work, E. Step, illustrated. *Charles H. Kelly.*—Woodland Trees and How to Identify Them, J. H. Crabtree, illustrated. *Longmans and Co.*—British Birds, written and illustrated by A. Thorburn, in four volumes (vols. i. and ii.); Wild Animals of the Empire, E. H. Fisher (pictures in colours). *Methuen and Co., Ltd.*—Diversions of a Naturalist, Sir E. Ray Lankester, illustrated. *John Murray.*—Life-Histories of African Game Animals, T. Roosevelt and E. Heller, two vols., illustrated. *L. Reeve and Co., Ltd.*—The Potamogetons (Pond Weeds) of the British Isles, with Descriptions of all the Species Varieties, and Hybrids, by A. Fryer, illustrated by R. Morgan, continued from Mr. Fryer's Notes by A. H. Evans, and concluded by A. Bennett. *George Routledge and Sons, Ltd., and Kegan Paul and Co., Ltd.*—My Week-end Garden, E. L. Fox, illustrated. *Smith, Elder and Co.*—*The Minor Horrors of War,* Dr. A. E. Shipley, illustrated (dealing with various insect and other pests which cause disgust, discomfort, and often disease amongst our troops now fighting in all quarters of the globe). *The University Tutorial Press, Ltd.*—Junior Botany, Prof. F. Cavers. *T. Fisher Unwin.*—Chinese Forest Trees, Norman Shaw.

CHEMISTRY.

Baillière, Tindall and Cox.—Muter's Short Manual of Analytical Chemistry, new edition, illustrated, edited by J. Thomas. The general character and scope of the work remain unaltered; the changes and additions made have mainly been necessitated by alterations in the British Pharmacopœia, 1914. *G. Bell and Sons, Ltd.*—Quantitative Laws in Biological Chemistry, Prof. Svante Arrhenius, with diagrams. *J. and A. Churchill.*—Exposives: Their Manufacture, Properties, Tests, and History, A. Marshall, illustrated. *Constable and Co., Ltd.*—Text-Book of Elementary Chemistry, Dr. F. M. Perkin and E. M. Jaggers, illustrated; Life and Letters of Joseph Black, M.D., Sir W. Ramsay, illustrated; The Hydrogenation of Oils, C. Ellis, illustrated; Industrial Chemistry, A. Rogers and A. B. Aubert, new and revised edition, illustrated. *C. Griffin and Co., Ltd.*—A Text-Book of Inorganic Chemistry (in nine volumes), edited by Dr. J. Newton Friend, vol. ii., The Alkali Metals and their Congeners (Group I.), Dr. A. Jamieson Walker; vol. iii., The Alkaline Earth Metals and their Associates (Group II.), H. V. Briscoe and E. Sinkinson; vol. iv., Aluminium and its Congeners, including the Rare Earth Metals (Group III.), H. F. Little; vol. v., Carbon and its Allies (Group IV.), Dr. R. M. Caven; vol. vi., Nitrogen and its Congeners (Group V.), Drs. J. C. Withers and H. F. V. Little; vol. vii., Sulphur and its Congeners (Group VII.), Dr. D. F. Twiss and A. V. Eldridge; vol. viii., The Halogens and their Allies (Group VII.), Dr. G. Martin and E. A. Dancaster; vol. ix., Iron and the Transitional Elements (Group VIII.), Drs. J. Newton Friend and W. E. S. Turner. *Longmans and Co.*—An Amateur's Introduction to Crystallography (from Morphological Observations), Sir W. P. Beale. *Macmillan and Co., Ltd.*—Chemical Technology and Analysis of Oils, Fats, and Waxes, Dr. J. Lewkowitsch, vol. iii., fifth edition, entirely rewritten and enlarged, edited by G. H. Warburton, illustrated. *Methuen and Co., Ltd.*—Practical Physical Chemistry, J. B. Firth. *Williams and Norgate.*—Food Industries: an Elementary Text-Book on the Production and Manufacture of Staple Foods, Dr. H. T. Vulte and S. B. Vanderbilt; Examination of Lubricating Oils, Dr. T. Stillman; A Popular Treatise on the Colloids in Industrial Art, Prof. K. Arndt.

ENGINEERING.

Chapman and Hall, Ltd.—Surveying Manual, Prof. H. C. Ives, illustrated. *Constable and Co., Ltd.*—Mechanical Technology, Prof. G. F. Charnock, illustrated; Internal Combustion Engine, H. E. Wimperis, new, revised, and enlarged edition, illustrated; Gas, Gasoline, and Oil Engines, by G. D. Hiscox, new edition, edited and brought up to date by V. W. Page, illustrated; Letters and Journals of F. B. Morse, edited and supplemented by E. L. Morse, two vols., illustrated; Ship Form Resistance and Screw Propulsion, G. S. Baker, illustrated; Practical Design of Steel Framed Sheds, A. S. Spencer, illustrated; Surveying, J. Williamson, illustrated; Continuous Current Engineering, Dr. A. Hay, new and revised edition, illustrated; Manual of Reinforced Concrete, C. F. Marsh and W. Dunn, new, revised, and enlarged edition; Single Phase Electric Railways, E. Austin, illustrated; Overhead Transmission Lines, F. Kapper, translated by P. R. Friedlaender, illustrated. *Crosby Lockwood and Son.*—Civil Engineering Types and Devices, T. W. Barber, illustrated; The Principles of Urban Traffic, H. W. D. Schmidt, illustrated; Concrete for House, Farm and Estate, F. Ballard, illustrated. *Scott, Greenwood and Son.*—Steam Boilers and Combustion, J. Batey; Lathes, G. W. Burley; Reinforced Concrete in Practice, A. A. H. Scott. *The University Tutorial Press, Ltd.*—A First Course in Engineering Science, P. J. Haler and A. H. Stuart; Electrical Engineering, W. T. Maccall.

GEOGRAPHY AND TRAVEL.

A. and C. Black.—The Three Southern Continents, J. B. Reynolds, illustrated. *Cassell and Co., Ltd.*—Through Central Africa from East to West, C. Kearton and J. Barnes, illustrated. *Macmillan and Co., Ltd.*—Arabia Infelix, or, the Turks in Yamen, G. W. Bury, illustrated. *Methuen and Co., Ltd.*—Brazil and the Brazilians, G. J. Bruce, illustrated. *John Murray.*—Adventures in Africa, J. B. Thornhill, with map; Hunting Pygmies, Dr. W. E. Geil, illustrated. *G. Philip and Son., Ltd.*—The Human Geographies, E. Young and J. Fairgrieve, six books, illustrated:—Book I., Children Far Away; Book II., Homes Far Away; Book III., In the British Isles; Book IV., In the New World; Book V., In the Old World; Book VI., In Europe and Britain; Synthetic Atlas of Comparative Geography, E. G. R. Taylor, in eight parts. *George Routledge and Sons, Ltd., and Kegan Paul and Co., Ltd.*—Alone in the Sleeping-Sickness Country, Dr. F. Oswald, illustrated. *Smith, Elder and Co.*—With Scott: The Silver Lining, T. Griffith Taylor, illustrated.

Geology.

Félix Alcan (Paris).—La Géologie biologique, S. Meunier. *Armand Colin (Paris).*—Les grands tremblements de terre: Sismologie géologique, Montessus de Ballore, illustrated; La Face de la Terre (Das Antlitz der Erde), E. Suess, translated under the direction of Emm. de Margerie, tome iii., illustrated.

Mathematical and Physical Sciences.

G. Bell and Sons, Ltd.—X Rays and Crystal Structure, Prof. W. H. Bragg and W. L. Bragg, illustrated. *Longmans and Co.*—Elements of Optics, G. W. Parker. *Mills and Boon, Ltd.*—An Introduction to Heat, A. R. Laws and Dr. G. W. Todd, illustrated. *The Open Court Company.*—In "Classics of Science and Philosophy" an annotated translation by P. E. B. Jourdain of Georg Cantor's classical papers on transfinite numbers, and extracts from the Scottish Philosophers—Reid, Beattie, and Stewart—by Prof. G. A. Johnston. A supplementary volume to Prof. Mach's Mechanics; a new edition in two vols. of De Morgan's Budget of Paradoxes, with notes by Prof. D. E. Smith. *The University Tutorial Press, Ltd.*—Rural Arithmetic, A. G. Ruston; Text-Book of Magnetism and Electricity, A. W. Hutchinson.

Medical Science.

Félix Alcan (Paris).—Thérapeutique de la Circulation, Dr. Françon; Le Thorax et l'Emphyseme, la Chondrectomie, Dr. E. Douai. *Baillière, Tindall, and Cox.*—Krause's Aids to Physiology, revised edition, illustrated. *Cassell and Co., Ltd.*—A Manual of Bacteriology, Drs. G. Dreyer and E. W. A. Walker, illustrated; Diseases of the Nervous System, Dr. H. Campbell Thomson, new edition, illustrated. *J. and A. Churchill.*—Malay Poisons and Charm Cures, Dr. Gimlette; A Treatise on Human Anatomy, edited by Prof. C. M. Jackson, revised edition, illustrated; A Text Book of Diseases of the Skin, Dr. J. H. Sequeira, new edition, illustrated; Materia Medica, Dr. W. Hale White, new edition, based on the new (1914) British Pharmacopœia; Domestic Hygiene for Nurses, with some Physics and Chemistry, Dr. F. J. Smith, new edition. *H. Kimpton.*—A Textbook of Radiology, Dr. E. R. Morton, illustrated. *H. K. Lewis.*—The Extra Pharmacopœia, W. H. Martindale and Dr. Wynn Westcott, revised edition, containing, among other additions, a syllabus of the additions, deletions, and alterations in the new British Pharmacopœia; Swanzy's Handbook of Diseases of the Eye, new edition, revised and edited by Dr. Louis Werner; Occupational Diseases of the Skin, Dr. R. Prosser White; Delorme's Surgery in War, translated by Dr. H. de Meric; Diseases of the Nose and Throat, Dr. H. Tilley, new edition, illustrated. *J. B. Lippincott Company.*—The Diseases of Children, edited by Drs. M. Pfaundler and A. Schlossmann, English translation with an introduction by Dr. L. E. Holt: vol. vii., Diseases of the Eye in Infancy and Childhood and Disorders of Speech and Phonation in Childhood, illustrated. *Macmillan and Co., Ltd.*—Human Physiology, Prof. Luigi Luciani, translated by Frances A. Welby, with a preface by Dr. J. N. Langley, in five vols., illustrated, vol. iii., Muscular and Nervous Systems. *Methuen and Co., Ltd.*—Methuen's Health Series:—Throat and Ear Troubles, M. Yearsley; Health for the Middle-Aged, Dr. S. Taylor; The Care of the Teeth, A. T. Pitts; The Eyes of our Children, N. B. Harman.

Metallurgy.

Macmillan and Co., Ltd.—A Handbook of Metallurgy, Dr. C. Schnabel, translated by Prof. H. Louis, illustrated, third edition, vol. i. *Williams and Norgate.*—Metallurgy, H. Wysor, revised and enlarged edition.

Technology.

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Miscellaneous.

Félix Alcan (Paris).—Traité de Psychologie, edited by Prof. G. Dumas; Les Asthenies Psychiques, Dr. Deschamps; La Survivance de l'Ame, Cornillier. *Cassell and Co., Ltd.*—Chinese Pottery and Porcelain, R. L. Hobson, two vols., illustrated; Reminiscences and Letters of Sir Robert Ball, edited by W. Valentine Ball, illustrated; Rifles and Ammunition, H. Ommundsen and E. H. Robinson, illustrated; Modern Horse Management, Lieut. R. S. Timmis, illustrated. *Constable and Co., Ltd.*—Mithraism, W. J. Phythian-Adams, illustrated. *Duckworth and Co.*—Foundations of Normal and Abnormal Psychology, Dr. B. Sidis. *Methuen and Co., Ltd.*—My Life, by Sir Hiram S. Maxim, illustrated. *Macmillan and Co., Ltd.*—A History of Persia, Lieut.-Col. P. M. Sykes, two vols., with maps and illustrations; What is Living and what is Dead of the Philosophy of Hegel, Benedetto Croce, translated by D. Ainslie; Modern Philosophers: Lectures delivered at the University of Copenhagen during the Autumn of 1902; and Lectures on Bergson delivered in 1913, Prof. H. Höffding, translated by A. C. Mason; The British Empire, Sir C. P. Lucas; The Statesman's Year Book: Statistical and Historical Annual of the States of the World for the Year 1915, revised after official returns, edited by Dr. J. Scott Keltie, assisted by Dr. M. Epstein; Elementary Principles of Economics, Drs. R. T. Ely and G. R. Wicker, new edition, adapted for English students, by L. L. F. R. Price. *John Murray.*—Emma Darwin: A Century of Family Letters, 1792–1896, edited by her daughter, Henrietta Litchfield, two vols., illustrated; The Place-Names of England and Wales, Rev. J. B. Johnston; A History of the Gold Coast and Ashanti, from the Earliest Times to the Beginning of the Twentieth Century, W. W. Claridge, two vols., with map. *George Routledge and Sons, Ltd., and Kegan Paul and Co., Ltd.*—A Dictionary of Occultism, L. Spence; Giordano Bruno: his Life, Thought, and Martyrdom, W. Boulting; Best Books, part iii. (Classes F–K), W. Swan Sonnenschein. *Williams and Norgate.*—On the Cosmic Relations: Being an Outline of the Evolution of the Relations between the Soul and the External Universe, and a Summary of the Recognised Relations that are still so immaturely evolved as to be little understood, H. Holt, two vols.

THE BRONZE-AGE INVADERS OF BRITAIN.[1]

SOMEWHERE about the year 2000 B.C., when the peoples of Western Europe were beginning to learn the uses of bronze and to alter the style of their pottery, a race of invaders began to reach our shores who were totally different from any race which had lived in Britain before that time. The ancient British, although of various strains, were all of them of the long-headed type; they had projecting occiputs; their heads appeared as if compressed from side to side. But those Bronze age invaders had rounded heads, with flat occiputs; their heads had the appearance of having been compressed from back to front. European anthropologists name this round-head type of man "Celtic"; they regard him as an offshoot from the racial type which now attains its greatest purity in the mountainous countries of Central Europe—the "Alpine" type of race. We may take the Bavarian or Savoyard as good modern representatives of the ancient Celtic or Alpine type. They are usually men of short stature, with dark hair and skins, with short and wide faces, regularly modelled features, and rounded heads. The men who invaded England early in the Bronze age and buried their dead in round barrows, were of a different build of body; they were strong, tall, and muscular; they had long faces, rugged features, prominent noses, overhanging eyebrow ridges; we have reason to believe they were fair in hair and complexion. Although these early invaders of Britain had the "Alpine" form of head, it is not among the modern inhabitants of Savoy or of Bavaria that we can hope to find their ancestral stock. We are all agreed that they were continental in origin. Those who have studied our Bronze-age invaders—who have investigated their physical characters, their methods of burial, their domestic animals, their pottery, their weapons and ornaments, are almost unanimously of opinion that we must seek their ancestral home somewhere in that part of Europe which now lies within the bounds of the German Empire. Every year our knowledge of Europe during pre-Roman times becomes more exact, and I propose, once again, in the light of more recent discoveries, and particularly from the point of view of one who is a student of the human body, to seek for the origin of our round-headed ancestry. We shall find that this early invasion of England was but a side eddy of a racial movement which affected almost the whole population of Europe.

How far the British people were exterminated and replaced during the invasions which took place after Roman domination had come to an end is not easily decided. If the Anglo-Saxons brought a new tongue to England they brought no new physical type; in stature and in head form we cannot distinguish them with certainty from the Britons of the period of Roman occupation, nor from the older pre-Roman population. But in this earlier invasion, which began 2000 years before the Roman legions crossed the Straits of Dover, we have not the same difficulty; so distinctive is the head-form of the Bronze-age or "round-barrow" men that we recognise the type at a glance; the type was then new to England. Along all the counties on our eastern seaboard, from Caithness in the north to Dorset in the south, we have found the graves of this distinctive round-headed race. The Hon. John Abercromby, who is our leading authority on British pottery, weapons, and ornaments of the Bronze age, is of opinion that the round-headed invaders were few in number, and that, after gaining a foothold in Kent, they gradually spread northwards and westwards throughout our country. With that conception I cannot agree. The south-eastern part of England was apparently only one of the landing places; the researches which were carried out by Canon Greenwell and Mr. Mortimer leave us in no doubt as to their arrival in eastern Yorkshire; the round-heads became masters of it. The counties which bound the Firth of Forth formed another centre of the invasion; the round-heads conquered that part of Scotland. For our present purpose their extensive settlement in the lowlands of Aberdeenshire and along the southern shores of the Moray Firth are the most important. In recent years Prof. Reid and Dr. Alex. Low, of the University of Aberdeen, have made us familiar with the Bronze-age men of the north-east of Scotland. These more northern invaders had their own peculiar kind of round-headedness, a kind remarkably flat on the crown—just as they had their own kind of graves, their own kind of pottery and ornaments. Sixty years ago that pioneer of anthropology—Prof. Anders Retzius, of Stockholm—identified a certain physical type in Aberdeenshire as similar to that which he had seen amongst the peoples in some of the Baltic provinces of Russia. The invaders who settled on the shores of the Firth of Forth, in Yorkshire, and in the south-eastern part of England have, like their more northern allies, their own distinctive traits in form of head, and in fashions of weapons and pottery. We find a difficulty in explaining the distribution and characters of the "round-head" invasion, if we suppose, as Mr. Abercromby does, that there was only one point of landing, but all our facts find an easy solution if we suppose that the invasion which occurred in the Bronze age, was similar in character and in extent to that which took place in Anglo-Saxon times.

We must presume, then, that those round-headed people, like the Anglo-Saxons, crossed the North Sea; we must presume further that the "round-heads" were then the dominant power in the North Sea. There are certain considerations which make such a presumption difficult to accept. Then, as now, the Continental shores of the North Sea were inhabited chiefly by long-headed peoples. We do know, however, that before the beginning of the Bronze age the "round-heads" had broken through from the hinterlands of Germany and had reached the coast at various points between Scandinavia in the north and Brittany in the south. It is somewhat difficult to believe that a round-headed people were master mariners; sea-power has usually been the appanage of long-headed nationalities; the Spaniards, the Portuguese, the Dutch, Norwegians, and British were, and are, predominantly long-headed. However that may be, we know the round-heads reached the Orkneys, the Hebrides, and the western shores. They spread across the lowlands of Scotland and crossed over to

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[1] Presidential Address delivered to the Royal Anthropological Institute of Great Britain and Ireland, on January 26, by Prof. Arthur Keith, F.R.S.

Ireland, where they formed numerous settlements in the north and east. The late Sir William Wilde believed—sixty years ago—that they were the aboriginal inhabitants of Ireland, but we know now that Ireland had been the scene of many an invasion before the round-heads reached her shores. The invading race spread over the richest parts of England; they reached Wales.

We are not yet in possession of sufficient evidence to determine how far the round-heads replaced the older inhabitants of Britain. There were several parts of England, Wales, Scotland, and Ireland which they failed to penetrate; at least we have not found in these parts their peculiar "round-barrow" graves. But in other parts their influence was pronounced. In the Museum of Comparative Anatomy at Oxford there are seventy skulls of people buried in round barrows during the earlier part of the Bronze age; thirty of them are apparently pure representatives of the round-headed race; among sixty-seven skulls gathered from the older or long barrows there is not a single representative of the round-headed people. Dr. William Wright found that the round-heads formed 29 per cent. of the people buried in the round barrows of Yorkshire. In the Aberdeenshire graves of the Bronze period Prof. Reid observed that eleven out of twelve skulls were of the rounded type. Were we to argue from the people buried in the peculiar graves of the early Bronze period we should infer that the invaders had influenced the British population to a profound degree. We have reason to believe that the people buried in the barrows or in cist-graves represent not the population as a whole but only a class—the richer or governing class. I had occasion recently to examine a hundred skulls from a disused London cemetery—representative of the working population—and found that only three showed clear signs of a Bronze-age ancestry. It is unusual to see a head of this rounded type on a British artisan. It is otherwise in the classes from which we draw our Civil Servants, our squires, and professional men. In a West End club, chiefly recruited from these classes, the Bronze-age type of head can be traced in about 20 per cent, of its members. I have said that the counties round the Firth of Forth were centres of settlement. Sir William Turner found that 25 per cent. of modern skulls from these counties were of the short or rounded type. The population of Kent, which has been the scene of more than one round-headed invasion in pre-Roman times, is eminently short-headed, or brachycephalic.[2]

We may speak with equanimity of an invasion which overwhelmed our country between 3000 and 4000 years ago; it brought in a strain of blood which still exerts its influence on certain classes of our population, and which has given us some of our most eminent men. I will cite only three instances—the first being Charles Darwin—one of the most acute and best balanced intellects ever bred in England. No one who has examined the bust which Woolner modelled from him in life can doubt his Bronze-age ancestry. His resemblance to Tolstoi is more than a superficial one. The second instance I shall cite from Scotland. We know the head-form of King Robert the Bruce, for a cast of his skull was taken before his remains were re-interred in 1819. An examination of that cast shows that Bruce possessed all the essential features of the Bronze-age race. Lastly, I take an instance from Ireland, where there are many descendants of the Bronze-age invaders, selecting that most lovable of men—Oliver Goldsmith. It is also a matter worthy of note that John Bull, as portrayed by "Mr. Punch," carries in his form of head a distinct impression of a Bronze-age ancestry.

So far as concerns the basis of the British population the invasion of the round-heads remained without effect; the mass of the people retained the long-headedness which had characterised their ancestors in the Neolithic and later Palæolithic ages. When we turn to France and mark the changes which occurred in her population at a corresponding period, we find the end result was totally different, there was a complete revolution in head-form; from being a long-headed people the majority of the French became round-headed. Long before the end of the Glacial period we find long-headed races in possession in France; even when the Glacial or Pleistocene period had ended and the Neolithic age was well begun, the native tribes of France retained the more ancient type of head. But even in the older or Pleistocene period we find some trace of the short-headed race. The skull found at Chancelade, in the Dordogne, in circumstances which convince us that its owner must have lived in one of the later phases of the Glacial or Pleistocene period, possesses certain definite features in its hinder or occipital region, which show affinity to the round-headed type. In the more superficial strata of a gravel pit at Grenelle, a suburb of Paris, a series of skulls have been found[3] which show all the features of our invaders of the Bronze age. In deeper and more ancient strata all the skulls were of the long type. There is good reason for believing that the Grenelle skulls, from both the deeper and more superficial strata, are of Pleistocene age.

Apparently then the round-head invasion of France had begun at a much earlier date than in England. M. Salmon collected measurements of the skulls of 688 people who lived in France during the Neolithic period—or, to make my meaning more clear, in a pre-Bronze age—and found that 58 per cent. were long-headed, 21 per cent. round-headed, the rest (21 per cent.) forming an intermediate group. A late Neolithic sepulchre in the Marne (Petit Morin) yielded a higher percentage of short-heads, viz., 27 per cent., while the long-headed group had become much reduced —34 per cent.

We see then that the round-headed invasion of France took place at a much earlier date than that of Britain. The French invaders, appear to have belonged to a different branch of the round-headed stock. It is true that north of the Seine one frequently sees amongst the skulls of Neolithic France the identical type which invaded Britain; we note the same strong and rugged faces, the same prominent supra-orbital ridges and the same flattened occiputs which characterise our British invaders. We suppose these northern forms must have come, like our ancestors, from across the Rhine. But the majority of the round-heads which then invaded France were of a different type; their foreheads were full and wide and destitute of great brow ridges; their faces were short and wide and of a less massive cast; their occiputs were rounded rather than flattened. They represent exactly what modern anthropologists have in mind when they speak of the "Alpine" race or type. The type deserves that name, for it evidently issued from the western flanks of the Alps and spread gradually over the whole of France. The revolution in head-form never passed beyond the Pyrenees. Long before the arrival of Cæsar in Gaul, the majority of the French people had become of the round-headed type. From Cæsar's time onwards the people who lived between the Loire and the Seine have been regarded as the representative of the true Celtic race. Our

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[2] See paper on Hythe Crania by Prof. F. G. Parson, Journ. Roy. Anthrop. Instit., 1908, vol. xxxviii, p. 419.

[3] See "Crania Ethnica," Quatrefages and Hamy, 1882.

Celtic-speaking people—the British "Celtic fringe"—belongs to a very different European stock.

The anthropological history of Italy is not unlike that of France. Very few remains of the people who lived in Italy before the dawn of the Neolithic period are known, but such as have been found lead us to believe that the early inhabitants were long-headed and apparently members of the dark-haired stock which inhabited the lands surrounding the Mediterranean—members of Prof. Sergi's "Mediterranean Race." Italy, like France, was apparently invaded from the flanks and passes of the Alps. In some of the graves of Lombardy, belonging to a later phase of the Neolithic period, we find skulls of a short-headed people. Some of these have the massive faces, the great supra-orbital ridges and the peculiar occipital flattening which characterise the Bronze-age invaders of Britain—but others, apparently the more numerous—are of the true Alpine type, the type which has left its influence on France. Long before the Etruscans and Romans had risen into prominence, the round-heads had permeated the northern half of Italy. I have lately examined the collection of crania which Dr. Niccolucci gathered from ancient Etruscan and Roman tombs—they are preserved in the Museum of the Royal College of Surgeons; fully a fifth of them manifest distinct traces of a round-headed ancestry. Collections of modern Italian crania show that the population has become increasingly brachycephalic since Roman times. In that Italy does not stand alone; it has been so with the population of France, Germany, Russia, Austria, and Greece. The anthropological surveys which have been carried out by Dr. Ridolfo Livi on army recruits drawn from all parts of Italy prove that in the southern half of the country the long-headed, dark-haired Mediterranean race is still the dominant population. But northern Italy is eminently round-headed.

It is generally agreed that the ancient Greeks were long-headed, and were members of the Mediterranean race, but apparently before they reached the heyday of their civilisation and of their power, a wave of round-heads had already penetrated the Balkan peninsula and reached the shores of the Mediterranean. The vast majority of the peoples inhabiting the Balkan Peninsula and the Austrian Empire manifest a high degree of brachycephaly. It was not always so along the valley and across the plains of the Danube. For instance, Prof. Toldt, of Vienna, did not find a single round-head in a collection of skulls gathered from ancient graves in upper Austria; 80 per cent. of the modern population is round-headed. So far as we can yet judge, the Danube Valley, in its width and length, was inhabited by a long-headed population in the Neolithic period. There is, however, an exception—the skull discovered fully thirty years ago by Prof. von Luschan at Nagy-sap, in Hungary, deeply embedded in the loess of the Danube, and presumably pre-Neolithic in date. Apparently before the Neolithic period had ended the round-heads of the true Alpine type began to penetrate the modern bounds of the Austrian Empire. The inrush of German-speaking peoples in post-Roman times did not stay the growing dominancy of the round-heads. Prof. Matiegka, of Prague, found that the remains of people buried in Bohemia during the ninth century A.D. yielded 14 per cent. of brachycephalic skulls, those of the sixteenth century yielded 70 per cent.; modern graves 85 per cent. The diverse peoples of the Austrian Empire—they are really more differentiated in speech than in racial type—have thus become dominated by a round-headed stock in comparatively recent times.

North of the Carpathians the story is the same. On the plains of Russia there are numerous mounds or tumuli—"kurgans"—containing the remains of ancient Russians. Seventy years ago Russian anthropologists began to investigate these mounds; they found from their contents that some of them dated back to the Neolithic period, others were of the Bronze age. They found, too, that the people buried in the older mounds were of the long-headed type—not unlike the men whose remains lie in our long barrows. The best modern representatives of this type are the inhabitants of Scandinavia—I shall speak of this form as the Scandinavian type. I have examined lately a series of accurate casts—forty in number—made from skulls found in these ancient Russian mounds. Twenty-seven of these are of the Scandinavian type; only eight of them are round-headed. Of these eight, five show the features of our invaders of the Bronze age—the massive face, the strongly marked supra-orbital ridges, the flattened occiput. The remaining three are more of the Alpine type. The vast majority of the people within the bounds of European Russia are now brachycephalic; only in those Baltic provinces which lie to the south of the Gulf of Finland has the ancient Scandinavian type succeeded in surviving. In Finland, itself, the Scandinavian type has been replaced by the modern brachycephalic Finn. So far as we have gone the western parts of Russia afford the most probable cradle for the British invaders of the Bronze period.

The anthropological history of Germany is very similar to that of western Russia. To the eye of the anthropologist the modern German Empire falls into three very distinct, but very unequal parts. There is, in the first place, the western or coastal area—embracing Oldenburg, Holstein, Hanover, and parts of Westphalia, where the Scandinavian or Anglo-Saxon form of head is still the dominant type. From the evidence afforded by ancient graves, we have no doubt that the coastal or western German does represent the Neolithic population of Germany, and he does not differ materially from the ancient long-headed native of western Russia. Then there is the second or southern area, including Bavaria, Wurtemberg, Baden, and the upper areas of the Rhine Valley. The modern population of these lands is eminently brachycephalic. Anthropologists are agreed in regarding them as typical representatives of the Alpine race. When and how the change in head-form was effected in South Germany we do not know definitely, but ancient graves, even down to the time of the disruption of the Roman Empire, yield skulls of the long or Scandinavian type. Bavaria, Wurtemberg, and Baden have undergone a revolution in head-form, not unlike that which has overtaken the Austrian Empire and France. In all of them the primitive population has become "Alpinised." In the remaining part of the German Empire—the part which may be described as Prussian, and which contains at least two-thirds of the total population of the Empire—a transformation in head-form has occurred, very similar to that which has overtaken the earlier inhabitants of Russia. German anthropologists have made no attempt to estimate the extent to which the modern Prussian population has assumed the Russian or Slav form of head, nor has any special endeavour been made to ascertain when the change took place. Prof. Welcker of Halle, found that out of a small collection of thirty German skulls eighteen were brachycephalic. In an ancient Prussian cemetery which had been used between the ninth and twelfth centuries, 30 per cent. of the skulls were of the long type and 18 per cent. of the round. Four centuries ago Vesalius regarded flattening of the occiput—such as frequently occurs in our Bronze-age invaders—as a characteristic feature of the German head.

We look in vain for the ancestors of our Bronze-age invaders among the modern peoples who live along the German or Dutch shores of the North Sea. When, however, we turn to the investigations carried out by Danish anthropolgists during the last seventy-five years we find a key to our problem. The classical researches of Nilsson brought to light in the Neolithic graves of Denmark a people with exactly the same rounded form of head as that of our British invaders. It was at first believed that these round-heads were the original inhabitants of Denmark, but later discoveries showed that the long-headed race of the long-barrow or Scandinavian type—which also occurred in Neolithic graves—was the older form. Our Bronze-age ancestors had reached the Danish peninsula in the Neolithic period. Recently Prof. Nielsen has published a very instructive table, showing how the head-form has altered at various periods in Denmark. His table is as follows:—

	Dolichocephalic	Mesocephalic	Brachycepalic
Neolithic period ...	30	44	26
Early Iron period ...	60	29	3
Modern	12	55	33

The table shows that after the Neolithic invasion round-heads became almost as common as long-heads in Denmark. It will be remembered that the round-barrows have revealed a similar proportion in England. A further parallel between Denmark and England is seen in the fate of the round-heads. By pre-Roman times the long-head had again asserted its dominance in both countries; in Denmark the round-heads form only 3 per cent. of the pre-Roman grave skulls. But after the Roman period the histories of the two countries diverge; the high proportion of long-heads disappeared from the Danish population, so that now they form only about 12 per cent. There can be little doubt as to the cause of the recrudescence of round-heads in Denmark. Her land-frontier is open to Germany and her population has undergone a change in head-form similar to that which has overtaken the people of Prussian Germany in post-Roman times.

In Denmark, then, we may recognise two invading waves of round-heads; but it is the oldest—the Neolithic wave—containing men marked by all the physical characters which we recognise in the English round-barrow men which interests us here. That was the first wave of round-heads to break through the long-headed population in Western Europe and reach the shores of the North Sea. Before the next wave broke, the Danes had apparently become again a long-headed people. Denmark was not the only country to suffer from the first invasion. Our "round-barrow" race had formed the settlements in the south of Sweden and on the south-western coasts of Norway. Even now, as in parts of England, the descendants of that early invasion can be traced in the lands in which the round-heads settled. The round-heads also reached the lands at the mouths of the Elbe, Wesser, and Ems. Oldenburg, between the estuaries of the Wesser and the Ems, has yielded Neolithic graves. Out of four skulls from such graves one is similar in form to that of our Bronze-age invaders. Apparently, too, they reached the coast by way of the Rhine. At least the Dutch people living in districts near the mouth of the Rhine show a much higher degree of brachycephaly than their neighbours either to the north or south. We have already traced the entrance of our Bronze-age type into northern France in the Neolithic period. They, too, reached the coast of Normandy.

We have made a tour round Europe in search of the native land of our Bronze-age invaders. We have merely found secondary settlements along the eastern shores of the North Sea and the possible points of their embarkation. Their native land we have not discovered. Our predecessors, when in difficulty over the origin of a European race, fell back on Asia; they had an infallible belief in the racial potentiality of that continent. There is now a distinct change amongst European anthropologists in their attitude towards such problems. They believe that our own continent may have produced its own races. But so far we have searched in vain for the cradle of the European round-headed stock; we have found neither the beginning of the dark-haired true Alpine type nor of the fair-haired northern form from which our round-barrow men sprang. But it is lawful for us to infer that the centre of dispersion is the probable cradle of origin. Now all the evidence at our disposal points to the central mountainous region of Europe as the centre of dispersion. It is therefore in the plains along the northern flanks of the central mountainous region of Europe that we may expect to find the cradle of our round-headed British ancestry.

The conquest of Europe by the "round-heads" is one of the most amazing revelations of prehistoric research. The outlook for the future of the fair-haired, long-headed stock does not, at first sight, seem very promising. Prof. Gustav Retzius, when he delivered the Huxley Lecture before this institute in 1909, gave expression to such a view. "There lie," he said, "in the circumstances to which I have called attention, a very real danger of the north European long-headed race not being able to hold its own. Just as it has been ousted during the past thousand years from Germany and other countries in Central and Eastern Europe by the dark-haired, small-statured round-heads, it will probably have to yield in Britain too, and be reduced in numbers, perhaps by degrees disappear entirely out of the fatherland of their ancestors and of themselves, by reason of the ever-increasing might and power of industrialism with which they seem ill-fitted to cope successfully in the long run. The prospect is depressing, it cannot be denied, but the development of things in the world is not seldom harsh and unmerciful."

Prof. Retzius's statement is that of a man who commands the respect and esteem of all anthropologists; he speaks of the fate of his own—the Scandinavian—racial stock, and is therefore predisposed to take the most hopeful outlook possible. It is beyond denial that in France, Austria, Russia, and in the greater parts of Germany and Italy a round-headed stock has ousted a long-headed one. Scandinavia, England, and Spain have escaped this domination by reason of their comparative isolation. Yet I dare think the future of the big-bodied, fair-haired, long-headed European stock may be more prosperous than Prof. Retzius is inclined to think. In the first place we have clear proof that at one time—some 4000 or 5000 years ago—the round-headed stock did break through and reach the western shores of Europe. It leavened England, but became submerged; it met a similar fate in western Germany and in Holland. In the earlier centuries of the present era the long-heads in north-western Europe must have undergone a recrudescence in numbers and in power. They broke eastwards on the plains of the Vistula and Danube; they imposed their speech on the conquered peoples, but the vanquished imposed on them their features of face, head, and body. They broke westwards into France, and lost both their tongue and their head-form; they crossed the North Sea and kept both their tongue and their shape of head. Sea power is also a potent factor in anthropology, and so far such power in Europe has been in the hands of long-headed stocks. What the long-head has lost in Europe he has gained in countries which lie beyond the seas, by virtue of his command of the sea. It is too soon to speculate on what the head-form of these new trans-oceanic settlements is to be—but all the signs point rather to a victory of the long-heads.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The following advanced courses of lectures, to which admission is free, are now being delivered:—A course, with practical work, in dynamical meteorology, at the Meteorological Office, South Kensington, S.W., by Dr. W. N. Shaw; a course on the Protozoa, at the Lister Institute of Preventive Medicine, Chelsea, S.W., by Prof. E. A. Minchin; a course on metabolism in infancy, at Guy's Hospital, Borough, S.E., by Dr. M. S. Pembrey and Mr. J. H. Ryffel; a course on certain aspects of British ecology, at University College, Gower Street, W.C. The remaining lectures of the last-named course are by Prof. R. H. Yapp (fen vegetation), Prof. G. S. West (the occurrence and distribution of fresh-water algæ), and Mr. A. D. Cotton (the algal vegetation of the salt-marsh and seashore).

MANCHESTER.—The Council of the University, with the approval of the Board of Agriculture and Fisheries, has appointed Mr. W. Percy Middleton Stock Officer for the counties of Lancashire and Cheshire. Mr. Middleton will be attached to the Department of Agriculture, and will be given an office in the University buildings as well as an office in a central position in each of the two counties.

OXFORD.—The annual report of the Committee for Geography, just published, gives a full account of the work done in the geographical department during the past year. The number of students working at geography was forty-one (twenty-three men and eighteen women). Lectures to the number of 124 were delivered by the professor (Dr. A. J. Herbertson, Wadham College) and his assistants, the subjects including natural regions of the British Empire, economic geography, Central Europe, the geographical distribution of man, climate and vegetation regions, topography of Europe, the Oceans, the British Isles, meteorology, influence of the geography of Greece on its political history, and the art of geographical description. Besides these, special lectures were given by Prof. T. Edgeworth David, Sir Ernest Shackleton, and others. Many field excursions were undertaken, and the report includes a long list of gifts to the library and collections. A successful vacation course was held in August, which was attended by 160 pupils (54 men and 106 women).

SHEFFIELD.—Dr. A. J. Hall has been appointed to the post of lecturer in medicine.

THE Central Committee for National Patriotic Organisations, 62 Charing Cross, W.C., has issued, at the price of *2d.*, a list of publications bearing on the war. It comprises the titles of works likely to be useful to those persons anxious to understand the immediate causes and remote origins of the war, of volumes dealing with the war itself or with naval and military matters generally, and of pamphlets on these subjects sold at *6d.* or less. Full particulars are given as to where the volumes may be procured, and the pamphlets may be purchased through the Central Committee.

IT was announced to the students of Stevens Institute of Technology at their annual dinner in the Hotel Astor on January 23 that their ten-day campaign to raise 272,000*l.* had yielded 232,854*l.*, and that an extension of time had been granted in which the remainder might be collected. *Science* says that Dr. A. C. Humphreys, president of the institute, made the confident prediction that the whole amount would be raised by the end of the week. From the same source we learn that the Harvard University corporation has set aside 20,000*l.* to pay Belgian professors who have been driven from their land by the war and may give courses at Harvard University next year. Mr. J. R. Magee has left 4000*l.* and a certain further residuary portion of his estate to Haverford College, to be added to the general endowment fund.

THE Association of Teachers of Domestic Subjects has issued its annual report for 1914. During the year important work was accomplished by the association. Miss Ailsa Yoxall's book on the "History of the Teaching of Domestic Economy" was completed for the association; it was reviewed in the issue of NATURE for November 19 last (vol. xciv., p. 308). A long-considered salary scale received its final form, and suggested a rate of pay which, if adopted by education authorities, would bring domestic subjects teachers into line financially with those of general subjects. We understand the suggested scale is receiving sympathetic consideration by various education authorities. The report contains detailed accounts of the activities of the different branches of the association throughout the country, and these provide satisfactory evidence of a widespread desire to improve the teaching of the important practical subjects with which the members are particularly concerned.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 4.—Sir William Crookes, president, in the chair.—Prof. G. H. **Bryan** and R. **Jones**: Discontinuous fluid motion past a bent plane, with special reference to aeroplane problems. The present investigation is based on the theory of discontinuous fluid motion, and in particular on the recent developments of that subject by Sir G. Greenhill. Its object is to obtain a hydrodynamical estimate of the effects of camber on the lift and drift of a lamina moving through a fluid, the motion being two-dimensional, and regarding the lamina as an aerofoil. Instead of considering continuously curved laminæ, the investigation deals with laminæ the front and rear portions of which are plane, but which meet at a dihedral angle. The method is applicable to surfaces with two or more bends. The general conclusions are in agreement with experimental results, that a moderate degree of camber is beneficial in increasing the lift without a corresponding increase in drift.—Prof. A. **Fowler**: A new type of series in the band spectrum associated with helium. The band spectrum associated with helium, as previously described by Curtis and Goldstein, includes bands with single heads and bands with double heads. A preliminary analysis of this spectrum has led to the following conclusions:—(1) The doublets do not follow the ordinary law of band spectra, but can be arranged in two series of the type hitherto exclusively associated with line spectra, and can be represented by the usual formulæ involving the Rydberg constant. Nine bands of the main series, and four of the second fainter series, have been identified. (2) The two series may be likened to the principal and diffuse series in the case of line spectra, but the usual relation between such series is not certainly indicated, and no equivalent of the sharp series has yet been traced. (3) The doublet separations are not in accordance with those associated with line spectra; they diminish in passing along the series, but do not vanish at the limit. No regularity in the arrangement of the single bands has been recognised.—T. R. **Merton**: The spectra of ordinary lead and lead of radio-active origin. Wave-length measurements have been made of some of the principal spectrum lines of ordinary lead and the lead in pitchblende residues. It might reasonably be expected that small differences in the wave-lengths would be found, more especially in the case of any lines which belong to doublet or triplet series, since, according to the views of Prof. Hicks, an atomic weight term enters exactly into the separations of such doublets or triplets. No series have yet been discovered in the spectrum of lead, but it is probable that they exist, and an estimate of the order of the differences of wave-length to be expected, according to Prof. Hicks's views, is given. No differences of this order have been observed, the spectra taken in juxtaposition showing no differences of wave-length, whilst the wave-length measurements of seven of the most prominent lines in the two leads agree to 0·03 Å.U. A special comparison of the line $\lambda=4058$ Å.U. with the interferometer shows that the wave-lengths of this line in the ordinary and radio-active lead are identical to within 0·003 Å.U.—A. O. **Rankine**: The viscosity of the vapour of iodine. The paper records the method used by the author for measuring the viscosity of iodine vapour at four different temperatures ranging from 124° C. to 247° C. The basis of the method is the distillation of iodine from one vessel to another through a narrow capillary tube, the temperature of which could be varied. One of the vessels contains solid iodine, and is raised to 100° C., thereby establishing the driving pressure. The other vessel is immersed in a freezing mixture, so that the iodine which is transpired as superheated vapour is condensed there, the mass so transpired being determined by weighing the vessel, which is removable. The method gives, in repeated experiments, very consistent results, and the values obtained may be taken as accurate to about ½ per cent. The range of temperature variation is not large enough to make the results suitable for testing the validity of Sutherland's formula, but it is found that they are, at any rate, not inconsistent with that formula.

Physical Society, January 22.—Sir J. J. Thomson, president, in the chair.—Dr. A. **Russell**: Practical harmonic analysis. Making the assumption that the graph of a periodic function is given, the problem of the best way of determining the Fourier constants in the series equation which represents it is considered. The ordinary method of procedure is to neglect all the harmonics above a certain order and determine the coefficients of the harmonic terms by making the curve represented by this equation pass through a number of arbitrarily selected points on the given curve. This is the method used, for instance, by Runge and Grover. A serious defect in this solution is that the values found for the amplitudes of the harmonics, more especially for the higher harmonics, may be very different from their true Fourier values. The method gives no indication of the magnitude of these errors. Gauss pointed out many years ago that the solution of this limited problem could be written down at once mathematically, and that it was of importance in certain interpolation problems in astronomy. Another method has been suggested recently by Silvanus Thompson. He uses certain series formulæ for finding the Fourier constants. The author suggests other series formulæ of a similar kind, and gives numerical examples to illustrate the accuracy attainable by the use of infinite series formulæ. T. **Smith**: Measuring the focal length of a photographic lens. The focal length of a compound lens is obtained solely by focussing on the camera screen the image of a distant object on the lens axis by the complete lens and by each of its components separately. One additional focussing of the same object when the separation of the components is altered determines the focal lengths of each component. The method is both accurate and quick, and requires only a camera and the lens.

Challenger Society, January 27.—Dr. G. H. Fowler in the chair.—D. J. **Matthews**: Hydrographical observations on the ice patrol *Scotia* in the North Atlantic, 1913. The *Scotia* cruised in the ice-area from April 9 to August 3, 1913, and crossed the Labrador current fourteen times between the latitude of Hamilton Inlet in 54° N., and the southern part of the Newfoundland Banks in 44° N. Observations of salinity and temperature were made down to a depth of 550 fathoms, including seven complete sections across the current. The Labrador current had a temperature generally below 0°, except at the surface, and a salinity of 32·5 to 33·5 per thousand, while the Atlantic water to the eastwards reached 34·5 per thousand or more. The boundary between the two water-masses was marked by the isohaline of 34·00 in the region northward of the Banks; further south the conditions were more confused. The characteristic temperature minimum was found in all water of polar origin except on the Banks, where it was disturbed by the shallows. Measurements of currents and of the drift of bergs were made by means of mark buoys, either anchored to a sinker on the bottom or to a drag working at a depth of 1000 fathoms. The velocities observed were all low, generally less than half a mile an hour, and calculations by Bjerknes's method from differences of density gave similar results. Off Cape Race a slow northerly set was observed instead of one of about one mile per hour to the south and west, as is usually experienced here. On the Banks measurements were made with the Ekman current-meter at depths of five and twenty-five fathoms at two stations; the observations were repeated at frequent intervals during thirteen hours, and showed that the current is almost entirely tidal with a very small easterly resultant. Prof. Barnes's observation that the proximity of an iceberg can be detected by a slight rise in the temperature of the water could not be confirmed, as similar rises were recorded when no ice was near.—C. Tate **Regan**: Colour-changes in a flat-fish, *Platophrys podas*.

Linnean Society, February 4.—Prof. E. B. Poulton, president, in the chair.—Ruth C. **Bamber**: Report on fishes collected by Dr. Crossland from the Sudanese coast of the Red Sea. This collection consists of ninety-one species, of which two are new to science and two others require re-description. Most of the others are typical Red Sea coastal fishes, and were obtained by Dr. Crossland at various localities on the Sudanese coast between Suez and Suakim.—Dr. Marie C. **Stopes**: A fossil of doubtful affinity. The fossil was found *in situ* in the Lower Greensand at Luccomb Chine, in a horizon in which a number of new plants as well as the famous *Bennettites Gib-*

sonianus have been discovered. The specimen in transverse section of an area of 20×35 cm. shows a uniform structure of most beautifully petrified tissue, which appears to be quite unlike any known fossil. Photomicrographs were exhibited showing the details of the tissues, which, in many respects, are like a giant phloem. The name *Vectia luccombensis* is proposed.—Dr. H. **Drinkwater**: Brachydactyly as an example of Mendelian inheritance. Brachydactyly (shortness of fingers and toes) has been studied by Dr. Drinkwater in four distinct families. In affected people, all the fingers and toes are short, and the stature is reduced. The chief defect is an extremely abortive condition of the second phalanx, which becomes ankylosed to the third, in two families. In the other two it is not ankylosed, and the fingers are not so short (Minorbrachydactyly), but the toes are alike in the four families. The epiphyses of the second phalanges are absent in the shortest fingers. The abnormals transmit the abnormality to about half their offspring. The normals never transmit the abnormality: it is bilaterally symmetrical and never skips a generation. It is a Mendelian dominant.

MANCHESTER.

Literary and Philosophical Society, January 12.—Mr. F. Nicholson, president, in the chair.—Prof. W. H. **Lang**: Studies in the morphology of Isoëtes. Part 2, the analysis of the stele of the shoot of *Isoëtes lacustris* in the light of mature structure and apical development. The author gives the results of a re-examination of the stele of *Isoëtes lacustris*, special attention being paid to points disputed or left obscure by previous investigators. From within outwards the following tissues can be distinguished: (1) central column of primary xylem; (2) peripheral zone of xylem, including the bases of the leaf-traces abutting on the central column of xylem; (3) parenchymatous xylem-sheath; (4) primary phloëm, continuous with phloëm of leaf-trace; (5) secondary prismatic tissue; (6) meristem of the anomalous secondary tissue; (7) cortical tissue. In some stems the meristem and the secondary tissue are completely wanting. The procambial tissue immediately behind the growing point gives rise to the central column of primary xylem. The other primary tissues of the stele are differentiated in the inner portion of the radiating rows of procambial cells surrounding the central region; the cortex is derived from the outer portion of this radiating tissue. There is thus a radial seriation of the elements from the outer xylem to the cortex quite independent of any secondary growth. The inner xylem is regarded as centripetal in relation to the poles of the leaf-traces applied to it, these being the only equivalents of protoxylem. The outer xylem lies between and outside the protoxylem poles. It is thus comparable, on the one hand, with the outer primary xylem of the Filicales, and, on the other, corresponds in position to the normal secondary xylem of the Lepidodendreæ. On this view a stele of Isoëtes would contain tissues corresponding to the centripetal primary xylem, the normal secondary xylem, and the anomalous secondary xylem (found in some species) of Lepidodendreæ.

PARIS.

Academy of Sciences, February 1.—M. Ed. Perrier in the chair.—Armand **Gautier**: The soldier's ration in time of war. The work of Atwater on the heat actually evolved in the human body by the constituents of food, proteids, fats, and carbohydrates, is made the basis of the discussion. This is supplemented by data derived from the study of two peasant families carried out over a period of twelve months, of railway workers, and of Belgian agriculturists. The average, in calories, for the daily food ration of workers in the north of Europe is 4349, for the French climate 3947, the difference being partly due to the higher temperature and partly to the higher weight of the inhabitants of northern Europe as compared with the French. The French army ration gives 3190 calories, and the author considers that in cold weather this should be supplemented by at least 900 calories, and argues that a portion of this, at least, should be in the form of wine.—G. **Gouy**: The Brownian movement according to Lucretius. An extract from "De rerum natura," in which the movements of motes in air strongly illuminated is ascribed to the action of the invisible movements of the atoms.—MM. **Brandt** and Darmezin **du Rousset**: A new form of polar extremities for electro-magnets used in surgery. A general description, without details, of flexible poles capable of being used in the extraction of magnetic fragments from wounds.—L. **Gay**: The solubility of hydrates.—José Rodriguez **Mourelo**: The phototropy of inorganic systems. Strontium sulphide. A study of phototropy, or the change of colour under the influence of light and of phosphorescence of strontium sulphide containing various proportions of manganese, or of manganese and bismuth together. The experimental results are given, the theoretical discussion being reserved for a later communication.—Lucien **Liais**: Waterproofing tissues by impregnation of the constituent elements. Observations on the measurement of the strength of tissues. Instead of waterproofing the woven material, the rubber solution is introduced on the thread during weaving. The method has the advantage of preserving the ordinary appearance of the finished material, and as compared with the ordinary waterproofing process the material is more resistant to wear by friction.—R. **Chudeau**: The geology of the Timbuctoo-Taoudeni-Kidal and Gao regions.—G. **Arnaud**: The suckers of Balladyna, Lembosia, and Paradiopsis.—Maxime **Ménard**: The localisation of projectiles and the examination of the wounded by the X-rays. A discussion of the comparative advantages of the radioscopic and radiographic methods. The former cannot guide the surgeon during the actual operation, may cause grave burns to the operator, and even when carefully conducted may fail to discover certain foreign bodies. A modification of Hirtz's radiographic method is described as advantageous, and details of eight operations chosen from a total of eighty-eight are given.

BOOKS RECEIVED.

Memoirs of the Colombo Museum. Series A. No. 1. Bronzes from Ceylon, chiefly in the Colombo Museum. By Dr. A. K. Coomaraswamy. Pp. 31+xxviii plates. (Colombo, Ceylon: The Museum.)

Notes on Practical Physics for Junior Students. By Prof. C. G. Barkla and Dr. G. A. Carse. Pp. xii+118. (London: Gurney and Jackson.) 3*s*. 6*d*. net.

Manual del Entomologo. By P. L. Navas. Pp. 79. (Barcelona: Tipografia Catolica.)

Dew-Ponds: History, Observation, and Experiment. By E. A. Martin. Pp. 208. (London: T. Werner Laurie, Ltd.) 6*s*. net.

Physical Geography. By P. Lake. Pp. xx+324. (Cambridge University Press.) 7*s*. 6*d*. net.

Sewage Purification and Disposal. By G. B. Kershaw. Pp. x+340. (Cambridge University Press.) 12*s*. net.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College, September-November, 1914. Edited by R. M. Milne. Pp. 28. (London: Macmillan and Co., Ltd.) 1*s*. net.

Subjects for Mathematical Essays. By Dr. C. Davison. Pp. x+160. (London: Macmillan and Co., Ltd.) 3*s*. 6*d*.

Heaton's Annual. The Commercial Handbook of Canada and Boards of Trade Register. Eleventh year. Pp. 514. (Toronto: Heaton's Agency.) 5*s*.

University Correspondence College. The Calendar 1914–15. Pp. 142. (London: University Tutorial Press, Ltd.) 1*s*. net.

Junior Algebra. By A. G. Cracknell and A. Barraclough. Pp. vi+280. (London: University Tutorial Press, Ltd.) 2*s*. 6*d*.

Marvels of Insect Life. Edited by E. Step. Pp. viii+486. (London: Hutchinson and Co.) 10*s*. 6*d*. net.

The Drama of the Year in South Africa. By M. Ritchie. Pp. x+118. (London: T. C. and E. C. Jack.) 2*s*.

The Journal of the South-Eastern Agricultural College, Wye, Kent. No. 22. Pp. 561. (London: Headley Bros.)

Evolution and Disease. By Dr. J. T. C. Nash. Pp. viii+73. (Bristol: J. Wright and Sons, Ltd.) 3*s*. 6*d*. net.

Dynamometers. By Rev. F. J. Jervis-Smith. Edited and amplified by C. V. Boys. Pp. xvi+267. (London: Constable and Co., Ltd.) 14*s*. net.

Masonry as Applied to Civil Engineering. By F. Noel Taylor. Pp. xi+230. (London: Constable and Co., Ltd.) 6*s*. net.

Foundations of Plant-Breeding. By Dr. J. M. Coulter. Pp. xiv+347. (New York and Chicago: D. Appleton and Co.) 6*s*. net.

A Guide to the Fossil Remains of Man in the Department of Geology and Palæontology in the British Museum (Natural History), Cromwell Road, S.W. Pp. 30. (London: British Museum (Natural History). 4*d*.

University College of North Wales. Calendar for the Session 1914–15. Pp. 404. (Manchester: J. E. Cornish, Ltd.)

Squire's Pocket Companion to the British Pharmacopœia. By P. W. Squire. Second edition. Pp. xvi+1040. (London: J. and A. Churchill.) 10*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 11.

ROYAL SOCIETY, at 4.30.—*Lepidostrobus Kentuckiensis*, formerly *Lepidostrobus Fischeri*, Scott and Jeffrey; A Correction: Dr. D. H. Scott.—The Excitatory Process in the Dog's Heart. II.: The Ventricles: T. Lewis and M. A. Rothschild.—The Variation in the Growth of Mammalian Tissue *in vitro* according to the Age of the Animal: A. J. Walton.

ROYAL INSTITUTION, at 3.—Nations as Species: Dr. P. Chalmers Mitchell.

INSTITUTION OF ELECTRICAL ENGINEERS at 8.—Conditions Affecting the Variation in Strength of Wireless Signals: Prof. E. W. Marchant.

CHILD STUDY SOCIETY, at 6.—With the British Association in Australia: Dr. C. W. Kimmins.

ROYAL SOCIETY OF ARTS, at 4.30.—Tribes of the Brahmaputra Valley: Sir George D. Dunbar, Bart.

FRIDAY, FEBRUARY 12.

ROYAL INSTITUTION, at 9.—Recent Advances in Oceanography Dr. W. S. Bruce.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

PHYSICAL SOCIETY, at 8.—Annual General Meeting.—The Criterion of Steel Suitable for Permanent Magnets: Prof. Silvanus P. Thompson.—A Galvanic Cell which Reverses its Polarity when Illuminated: Alan A. Campbell Swinton.—An Investigation on the Photographic Effect of Recoil Atoms: A. B. Wood and A. I. Steven.

MONDAY, FEBRUARY 15.

ROYAL SOCIETY OF ARTS, at 8.—Motor Fuel: Prof. V. B. Lewes.

VICTORIA INSTITUTE, at 4.30.—Traces of a Religious Belief of Primeval Man: Rev. D. Gath Whitley.

TUESDAY, FEBRUARY 16.

ROYAL INSTITUTION, at 3.—Muscle in the Service of Nerve: Prof. C. S. Sherrington.

ILLUMINATING ENGINEERING SOCIETY at 8.—The Development and Design of Lighting Fixtures in Relation to Architecture and Interior Decorations: F. W. Thorpe.

ROYAL STATISTICAL SOCIETY, at 5.15.—The Magnitude of the Population of England and Wales Available for Emigration: Dr. E. C. Snow.

WEDNESDAY, FEBRUARY 17.

ROYAL SOCIETY OF ARTS, at 8.

INSTITUTION OF ELECTRICAL ENGINEERS, at 7.45.—(Student's Section).—Modern Power-House Condensing Plant: A. Arnold.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Presidential Address: Some of the Micro-biological Problems of the Present War: Prof. G. Sims Woodhead.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Observations of the Upper Atmosphere at Aberdeen by Means of Pilot Balloons: A. E. M. Geddes.—The Influence of Weather Conditions upon the Amounts of Nitric Acid and of Nitrous Acid in the Rainfall at Melbourne, Australia: V. G. Anderson.

THURSDAY, FEBRUARY 18.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Gaseous Combustion at High Pressures: Prof. W. A. Bone and Others.—The Orbits of a Charged Particle Round an Electric and Magnetic Nucleus; Prof. W. M. Hicks. The Lunar Diurnal Magnetic Variation and its Change with Lunar Distance: S. Chapman.

ROYAL INSTITUTION, at 3.—Struggle of Species: Dr. P. Chalmers Mitchell

LINNEAN SOCIETY, at 5.—The Action of Light upon Chlorophyll: H Wager.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The "Cracking" of Oils, with a View to Obtaining Motor Spirit and other Products. W. A. Hall.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, FEBRUARY 19.

ROYAL INSTITUTION, at 9.—The Visit of the British Association to Australia: Prof. H. E. Armstrong.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.

SATURDAY, FEBRUARY 20.

ROYAL INSTITUTION, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

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THURSDAY, FEBRUARY 18, 1915.

VITAL STATISTICS.

Vital Statistics Explained: Some Practical Suggestions. (The Chadwick Library.) By J. Burn. Pp. x+140. (London: Constable and Co., Ltd., 1914.) Price 4*s.* net.

IN a preface to this work Sir William Collins, as chairman of the Chadwick Trust, explains that the volume is based upon a course of lectures delivered at Liverpool, under the auspices of that trust. Mr. Burn pays a high compliment to the present Registrar General on the improvements introduced by him into the annual reports of his department, and says that it is now for the first time "possible to discuss and analyse the enormous mass of statistics in a coherent and intelligent manner."

The author deals first with the Census as an index to the development of national life. A comparison of the twelfth census, taken in 1911, with the first, taken in 1801, shows a wonderful advance. Mr. Burn thinks that nearly all the information that can be relied upon is now collected. He deprecates further elaboration. "Merely to ask an extra question on the census paper does not ensure a correct answer being given."

The leading facts that are shown by the Census returns and the reports of the Registrar General are: (1) a steady decline in the marriage rate during the last thirty years; (2) a steady increase in the mean age at marriage for both sexes; (3) a reduction in the birth-rate, both as regards legitimate and illegitimate births; (4) a reduction in the infantile death rate. While these observations are closely related, they point to a number of contributing causes.

The success which has attended the measures that have been taken of late years for sanitary improvement is shown by the statistics of death from various diseases. Small-pox is practically non-existent. Phthisis and tuberculosis have decreased by more than 50 per cent. during the sixty years since 1851. On the other hand, the deaths from cancer have greatly increased. All these statements have to be qualified by the possibility of differences of definition in successive records.

After a brief chapter on the preparation of mortality tables, in which he suggests that in addition to the national tables, municipal and occupational tables should be prepared, Mr. Burn proceeds to show how such tables may be put to practical use by medical men and other persons, and the light they might throw upon causes of death and upon the prevention of disease. For this purpose he has examined the rates of mortality of the industrial branch of the Prudential Assurance Society, of which he is actuary, and as these are derived from twenty million policies, he claims that they fairly represent the population of the United Kingdom, a claim which may at any rate be supported if limited to the industrial classes. He arrives at the satisfactory result that there is a steady and continuous improvement going on in the vitality of the country.

The proper method of graduating a mortality table so that the crude results of the enumeration may be smoothed into a symmetrical curve without destroying the trend of the facts, has exercised the minds of actuaries for some time. The late Mr. Woolhouse, Dr. Sprague, Mr. George King, and others have learnedly discussed it, and the method now generally adopted is that which the German actuaries call by the fanciful name of "osculatory interpolation." In an appendix to his volume, Mr. Burn gives a description of this method, so lucid and so simple that any person might employ it without having a knowledge of the mathematical principles upon which it is based. He has certainly the gift of clear exposition, and his little book is calculated to be useful to many persons to whom actuarial science has not hitherto offered any attraction.

TECHNICAL METHODS OF CHEMICAL ANALYSIS.

(1) *Technical Methods of Chemical Analysis.* Edited by Dr. G. Lunge and Collaborators; English translation edited by Dr. C. A. Keane and Collaborators. Vol. iii, part i, pp. xxxi+538. Vol. iii, part ii, pp. xv+539—1125. (London: Gurney and Jackson, 1914.) Two volumes. Price 3*l.* 3*s.* net.

(2) *Technical Gas-Analysis.* By Dr. Lunge. Pp. xv+407. (London: Gurney and Jackson, 1914.) Price 15*s.* net.

(1) THE two sections now issued of volume iii. of this important work complete the English edition of Dr. Lunge's great monograph published in German in 1910–11. The English edition, however, differs in certain material respects from that on which it is based, inasmuch as certain German processes are inapplicable, from the very nature of the case, to British procedure, and it is unlikely, owing to special conditions, that they will ever become applicable. Hence particular sections of the work have had to be entirely re-written by British experts from the British point of view, and to this extent these may lay claim to be original productions. At the

same time the remaining sections of the work have been revised by British authorities, and, wherever necessary, modified in the same sense. In addition, each section has been brought up to date by the inclusion of all relevant matter of importance.

The sections on mineral-oils, lubricants, oils, fats, and waxes, and the special methods of analysis employed in the oil and fat industries were contributed or revised by the late Dr. Lewkowitsch—an acknowledged authority on this class of subjects. Dr. Lewkowitsch also revised the English translation of Dr. Dieterich's article on resins, balsams, and gum-resins. The same author's article on drugs and galenical preparations has been revised by Dr. Power, who has also taken charge of Dr. Gildemeister's contribution on essential oils. The sections on tartaric and citric acids have been entrusted to Mr. Davis, whilst the general subject of organic preparations—a somewhat vague class—has been dealt with by the Editor. This section is concerned more particularly, although by no means exclusively, with pharmaceutical preparations, and is based upon an article by Dr. Messner of the firm of Merck and Co., of Darmstadt. The important section on rubber has been revised by Dr. Caspari, who, however, has nothing to say concerning synthetic rubber, from which we may infer how small has been the influence of the "boom" on "artificial rubber" on the actual production of this substance.

Vegetable tanning materials and leather have been revised by Prof. Procter, an acknowledged authority on the scientific aspects of tanning; whilst sugar, starch, and dextrin have been dealt with by Mr. Arthur R. Ling—no less an authority on these particular subjects—who has also re-written, in conjunction with Mr. Cecil Jones, a valuable article on brewing materials and beer. Paper has received the attention of Messrs. Cross, Bevan and Bacon; textile fibres that of Prof. Hübner, of the Manchester School of Technology; while Messrs. Rawlins and Rule have revised Prof. Eibner's article on inorganic colours. It will be seen, therefore, from this list of names that Dr. Keane has spared no pains in securing the collaboration of competent authorities on chemical analysis as applied to technical products and processes.

The book, like its predecessors, should find a place in the library of every consulting and analytical chemist, as well as in that of every well-equipped works laboratory. A very commendable feature of the work is the admirable bibliography which accompanies each article.

Another feature, even more valuable, is seen in the extent to which individual revisers have brought their special experience to bear upon the sections entrusted to them, thereby greatly enhancing their merit. This makes the English edition of the work doubly valuable, as compared with the German original, since each article has passed, so to say, twice through the refining fire of expert assayers.

(2) Prof. Lunge's book on technical gas analysis is in a sense the third edition of his well-known handbook of technical gas analysis, originally based upon the late Prof. Clemens Winkler's "Anleitung zur chemischen Untersuchung der Industrie-Gase." During the dozen years which have elapsed since the publication of the second edition of the handbook the subject has received an extraordinary development, and great changes have occurred in procedure and apparatus. The application of technical gas analysis has been largely extended, and its value as an analytical agent in industrial processes, and even in connection with hygiene, has been widely recognised. Hence the time had arrived when the comparatively narrow limitations of Clemens Winkler's treatise had to be discarded, and the book under review is, therefore, practically a new work, differing wholly in groundwork and arrangement from that on which it was originally based. So far as we have been able to discover, all branches of the subject have received adequate treatment. The bibliographical references are copious and up-to-date. Lastly, the book is well printed, excellently illustrated, and the indexes of authors' names and of subjects are remarkably full.

T.

TWO BOOKS ON THE EARTH.

(1) *Geology of To-day.* A Popular Introduction in Simple Language. By Prof. J. W. Gregory. Pp. 328. (London: Seeley, Service and Co., Ltd., 1915.) Price 5*s*. net.

(2) *College Physiography.* By Prof. R. S. Tarr. Published under the editorial direction of Prof. L. Martin. Pp. xxii+837. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 15*s*. net.

THESE two books are professedly written for two different types of reader; but the college student may well read Prof. Gregory's "popular introduction" from end to end, while the lover of "simple language" will find nothing to alarm him in the work of the late Prof. Tarr.

(1) Prof. Gregory has brought the latest results and the current discussions of geologists before every thoughtful person to whom the earth appeals. We possess a number of popular text-books on geology, but "Geology of To-day" justi-

fies its title, and stands entirely apart. The alarming illustration with which it opens, representing a statue of Louis Agassiz plunged head-downwards in the ground, is not symbolical of the tendencies of the text. The author traces the growth of geological philosophy without exulting over the imperfections of those who have gone before. The hardy old *pièces justificatives* are quoted, but are supplemented by observations of very recent origin. On p. 141, for instance, Day and Shepherd's work on the volcanic gases of Hawaii is cited in refutation of the critical thesis so enticingly maintained by Brun; but how many of our current text-books have got so far as mentioning Brun? He certainly never shook Tarr's faith in the potency of steam as a volcanic agent ("College Physiography," p. 444), and Prof. Gregory's references are all the more welcome as recording a really memorable, if short-lived, controversy.

The chapters on "How mountains are made," with its review of the possible influence of radium, and on "How mountains are upheld," with its lucid exposition of isostasy, are good examples of Prof. Gregory's method. The section devoted to life-history, occupying nearly half the book, contains no detailed description of stratified formations, but consists of essays on "The Origin of Life," "The Interpretation of Fossils," "The Evolution of Mammals," and so forth. Miss Alice Woodward has contributed some spirited original drawings of incidents in the life of fossil vertebrates, and Hagenbeck's models at Hamburg are also utilised. In these chapters the terrestrial and fluviatile origin of the Old Red Sandstone conglomerates is well stated (p. 204); we are introduced to Gigantosaurus of East Africa, the superdreadnought of land-animals (p. 259); and to the beaked flints from the English Pliocene (p. 306), for which the author is quite willing to accept a human origin.

On glacial matters he preserves considerable caution; here only his geology seems not quite of to-day, though it is that of a very recent yesterday. To describe (p. 212) the evidence of Permian glaciation as indicating that "the climate of parts of the Southern Hemisphere was therefore colder than it is at present," must be regarded as a very moderate statement. In his memorable journeys in Spitsbergen, Prof. Gregory (p. 227) was unfortunate in not coming across modern boulder-clays. The precise parallel between the material left behind by the von Post glacier and that of deposits in the British Isles would, for instance, have reassured him. Too little seems made of the fact that sheets of boulder-clay represent the unmeltable residue of glaciers that, in their lower portions, consist half of ice and half of stones. During the melting of such glaciers there is no copious flow in the lower layers sufficient to sweep away all the finer particles. The loamy matter settles downwards in the interstices of the abundant and striated stones.

The fine series of photographs of Javan volcanoes is very welcome. So is the whole of this stimulating volume. The author does not accept (p. 81) the opinion of German writers as to the origin of their own word *feldspath*; but A. Brongniart attempted the same thing in 1807 in his "Traité de Minéralogie" (p. 355) without success.

(2) The handsome book by the late Prof. Tarr and Mr. L. Martin is of the serious and detailed type suggested by its title. It owes much to the extensive and observant travels of Prof. Tarr, and particularly to his work on glaciers and recent uplifts in Alaska (pp. 214, 390, etc.). The illustrations are numerous, and some of the diagrams would bear enlargement, those on river-erosion, for instance, being not too clear (p. 557, etc.). The view of Innsbruck on p. 525 represents the snow of spring or autumn, but not "The Alps rising above the snow line." The illustrations, however, generally supplement in a valuable way those of European text-books. The treatment of the features due to stationary and shrinking ice-sheets is especially interesting (ch. ix). The last seven chapters, dealing with the atmosphere and terrestrial magnetism, are due to the faithful and experienced editor, Mr. L. Martin, who has worked and travelled with Prof. Tarr.

GRENVILLE A. J. COLE.

MATHEMATICAL TEXT-BOOKS.

(1) *Pendlebury's New Concrete Arithmetic.* By C. Pendlebury and H. Leather. First Year. Pp. 57. Price 4*d*. Second Year. Pp. 54. Price 4*d*. Third Year. Pp. 57. Price 4*d*. Fourth Year. Pp. 56. Price 6*d*. Fifth Year. Pp. 71. Price 6*d*. (London: G. Bell and Sons, Ltd., 1914.)

(2) *A First Course in Mathematics for Technical Students.* By P. J. Haler and A. H. Stuart. Pp. vi+125. (London: University Tutorial Press, Ltd., 1914.) Price 1*s*. 6*d*.

(3) *A Course of Geometry Theoretical and Practical: a Class-book for Secondary and Technical Schools.* By A. H. Bell. Pp. viii+127. (London: Rivingtons, 1914.) Price 2*s*. 6*d*.

(4) *A Treatise on Dynamics.* By Dr. W. H. Besant. Revised and enlarged by A. S. Ramsey. Fifth edition. Pp. xv+443. (London: G. Bell and Sons, Ltd., 1914.) Price 12*s*.

(5) *Examples and Test Papers in Algebra.* By W. J. Walker. Parts ii. and iii. Pp. viii+

163 + 338. (London: Mills and Boon, Ltd., 1914.) Price 1*s*. 3*d*.

(6) *Elementary Mathematical Analysis: a Text-book for First Year College Students.* By Prof. C. S. Slichter. Pp. xiv + 490. (New York and London: McGraw-Hill Book Co., Inc., 1914.) Price 10*s*. 6*d*. net.

(7) *Stability and Equilibrium of Floating Bodies.* By B. C. Laws. Pp. ix + 251. (London: Constable and Co., Ltd., 1914.) Price 10*s*. 6*d*. net.

(1) THIS set of books on arithmetic consists chiefly of examples, carefully graded in difficulty. No answers are given; teachers who use these books will look for an edition in which they are supplied. The course includes mensuration, percentage, and interest.

(2) The authors of this small text-book have succeeded in creating a "workshop atmosphere" around this elementary course; not only are the problems of a practical nature, but the student is frequently referred to drawings of simple forms of mechanism, which illustrate and furnish the data of the example set him. The range of the book includes practical arithmetic, mensuration, graphical work, and simple algebraic processes.

(3) This book is framed on the lines recommended by the circulars of the Board of Education, particularly in the first forty pages. It is claimed that the requirements of the ordinary leaving-school examinations are met, but the book is so small that most teachers will find it necessary to supplement it. There are comparatively few examples, those given being mainly numerical. Regarded as an introductory course, this small volume is of distinct merit.

(4) Dr. Besant's treatise on dynamics is well known to many generations of Cambridge men, and its re-issue in an enlarged form will doubtless be welcomed. Mr. Ramsey, who undertook a few years ago, at the author's request, the editing of part i. and the writing of part ii. of his treatise on hydromechanics, has also found time to edit and supplement this remaining volume. The increase in size is considerable, partly owing to additions to the text, but more to the very large number of problems which are now incorporated. Numerous illustrative examples are fully worked out, and notes are frequently appended to them, which the student will find instructive. We have no doubt that men reading for the second part of the Mathematical Tripos will find this volume most helpful.

(5) This collection of examples and papers is conservative in type. There is little note of originality either in arrangement or material. With regard to bookwork, only the chief theorems are inserted, and there is little explanatory matter. Part ii. includes progressions, variation, and gradients; part iii. contains the logarithmic and exponential series.

(6) This book, designed for first-year college students in America, corresponding roughly to the last stage in the secondary schools of this country, is intended to show the application of simple mathematical principles and operations to practical life. No great manipulative power is demanded of the reader; the author's object is to inspire him with new ideas and broaden his outlook. The central theme of the book is functionality. This is applied to power functions, exponential functions, and periodic functions; the fundamental transformations are treated from a kinematic point of view, by translation, rotation, and shear. The text is interesting throughout, and the author has collected an admirable set of practical exercises.

(7) This treatise for engineering students deals with the stability of bodies floating either in air or water. There are two introductory chapters which summarise the principles of rigid dynamics and hydrostatics, specially needed for the course. The author then passes to the stability of ordinary ship-forms, and this occupies nearly half the book, dealing with, among many other things, stability curves, trim curves, stability at high speeds, effect of wind and waves. In the next chapter he turns to submarines, the action of rudders, transverse stability, etc., and this is followed by the consideration of floating docks, aircraft, and caissons. The chapter on aircraft will probably be of interest to a wider circle than any other part of the book, and may be read independently. The clearness of the diagrams deserves a special word of praise.

OUR BOOKSHELF.

A First Book of Commercial Geography. By T. Alford Smith. Pp. viii + 151. (London: Macmillan and Co., Ltd., 1915.) Price 1*s*. 6*d*.

MR. ALFORD SMITH's book has many useful characteristics. It is clearly written, has good maps and diagrams, and a number of appropriate pictures, and includes well-chosen and suggestive examination questions. The scope of commercial geography, however, as specified here, may not appeal to all. The statement, for example, that in order to understand commercial geography it is necessary to know what processes an article has to undergo in order to become an article of commerce, needs cautious application; it is a fault of some larger and more advanced works in this subject that, in the direction especially of manufacture, they wander far outside geographical limits. And perhaps, on the other hand, there is lacking in the book under notice a sufficiently forcible exposition of the principles of geographical, and especially climatic, control over the distribution of products and the activities of man in making use of them. Thus, the regional division of the world according to climate and vegetation is only briefly, and not completely, referred to. It may be that some geographers have made climatic control a sort of fetish; it should not be that, but it deserves a very important place in the study of commercial geography, and calls for precise expression—as an illustration of this necessity it may be suggested that the statement in the present work that in Australia "wheat is grown up to the 20-in. line of rainfall" misses the real point of the conditions of rainfall which determine the wheat-growing area there. It should be noticed that Mr. Alford Smith inserts tables of statistics, wisely averaged, and among them details at considerable length of several large ports of the United Kingdom.

Atlas of Japanese Vegetation, with Explanatory Text. Edited by Prof. M. Miyoshi. (Set xv., 102–107.) (Tokyo: Maruzen Company, Ltd.; London: W. Wesley and Son, 1914.) n.d.

THIS continuation of Prof. Miyoshi's well-known atlas includes six beautiful collotype plates from photographs of the vegetation of the luxuriant mountain forests in the province of Shinano. Nothing could convey a better idea of the wonderfully varied plant communities of Japan than this carefully selected series of photographs with the accompanying descriptions, the latter being in English and in Japanese. From its geographical position, especially its great range in latitude, Japan shows a much more varied flora than any other country of similar area, from the tropical vegetation of Formosa to the alpine floras of the high mountains and the semi-arctic flora of the extreme north. The descriptions, though brief, contain much that is of interest; for instance, we learn that when the curious "luminous moss," *Schistostega osmundacea,* was discovered in one of the habitats depicted in the atlas, the Japanese Government immediately acceded to Prof. Miyoshi's request that the locality should be made a nature reserve. It is interesting to note that in this series several species of wide range in the temperate regions and familiar members of the British flora are described as growing along with characteristic Japanese flowering plants, the latter including various species well known in Britain as cultivated plants.

Materials of Machines. By A. W. Smith. Second edition. Pp. v+215. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 5*s.* 6*d.* net.

THIS book furnishes a very elementary treatment of the manufacture and properties of materials used in the construction and operation of machines. In the first part the author deals with fuels, refractory materials, electric furnaces, and the metallurgy of iron, steel, copper, lead, tin, zinc, and aluminium in rather less than ninety pages of a small book, and remarks in his preface that an understanding of this is essential to the study of the second part, which in 102 pages treats of the testing of materials, the iron-carbon equilibrium, cast iron, wrought iron, steel, its heat treatment, and non-ferrous alloys. The final ten pages are devoted to the selection of materials for the various parts of a steam-engine. Seeing that the metallurgical section of the book deals exclusively with the extraction of the metals named from their ores, and ignores their mechanical treatment, the only connection between parts i. and ii. relates to the metals and alloys, *e.g.*, cast iron and cast steel which are used in the cast state. Considering that the great bulk of the various steels used in machines are "worked," this omission must be regarded as unfortunate. It is certainly an astonishing thing that the author, who is an American, should apparently not know the modern processes of extracting copper which have been developed entirely in his own country, and should have described a process which originated in Swansea, and has been superseded by them. To describe the metallurgy of copper in fewer than five pages as attempted by the author is a task that few metallurgists would undertake.

Nerves. By Dr. D. F. Harris. (Home University Library.) Pp. 256. (London: Williams and Norgate, n.d.) Price 1*s.* net.

PERHAPS the most difficult field of physiology to reduce to simple form and language, so that it may be understood by the non-scientific laity, is that of the nervous system. Any attempt in this direction, which is accurate, is sure of a welcome. Prof. Harris, in the small volume under review, has certainly succeeded in his attempt to explain in non-technical language the place and powers of the nervous system. He does not deal with the question of the morphology and pure physiology of the cerebrum and spinal cord, nor does he consider psychology—as physiology and psychology have been dealt with already in other volumes of the series. In reality the author deals mainly with the reflex arc and its value to the organism; he also briefly discusses the causes and the value of sleep to the organism, and considers, very shortly, the conditions of "nervousness" and "excitability," their nature, and the possibility of their prevention.

On the whole the author's statements are extremely clear and trustworthy, although some of his generalisations are apt to be too sweeping. For example, it will not be generally conceded that "the transcendent nonsense of the post-impressionist painters arose from absinthe-poisoned blood" acting on an abnormal nervous system. Nor is the evidence that muscular activity is the result of the propagation of a special form of energy generated from the Nissl granules of the cerebral cells held to be, to say the least of it, convincing. Still the book is interesting and is worthy of its place in the series.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Fine Chemicals for Research Purposes.

IN view of the shortage of fine chemicals which are used for research purposes, we thought it advisable to issue a circular to the principal laboratories in the kingdom asking for lists of chemicals not in immediate use, so that it would be possible to put the holders of such chemicals in touch with those chemists who were in urgent need of them. The replies which have been received so far have been in most cases to the effect that the holders wish to keep their own stocks in hand, but are willing to use our bureau for the purpose of purchasing others. As this attitude is one which entirely defeats the object with which the inquiry was started, may we direct the attention of chemists to the fact that it is impossible for them all to hold and to purchase at the same time. An equitable series of exchanges is all that can be arranged at the present time; and it should be remembered that even 50 grams of some particular substance may make all the difference between the carrying on or the hanging up of a piece of research work.

H. B. BAKER.
J. F. THORPE.
M. A. WHITELEY.

The Imperial College of Science and Technology,
South Kensington.

A Penalty on Research.

I AM sure that the biologists of the country will support Sir Wm. Ramsay's protest in NATURE of February 11, on the penalties incurred by men of science for the use of alcohol in their investigations. A few years ago I received a consignment of specimens of natural history in alcohol from a foreign Government expedition for scientific study and description. After some correspondence with the Customs House authorities I was allowed *as a concession* either to pay the full duty on the alcohol, or, in the presence of an officer, to pour it down the sink in the University laboratory, and replace it by methylated spirit at my own expense. Comment is unnecessary.

SYDNEY J. HICKSON.

The University of Manchester.

The Prices of Chemicals.

A WELL-KNOWN firm of dealers in chemicals and laboratory apparatus gave a quotation some days ago for the supply of an ounce each of dulcite and adonite. They proposed to charge 9*l*. 10*s*. for the former and 6*l*. for the latter. In the price list of chemicals issued by the same firm some months before the war the prices were respectively 45*s*. and 18*s*. Is there any good reason (except greed) for this increase of price? Presumably this firm, or some other English firm with which they deal have held a stock of these sugars since before the war. The substances are indispensable in public health bacteriological work, and is it not possible that some university laboratory can undertake their preparation and distribution at cost price?

J. J.

The University, Liverpool, February 3.

WE are in receipt of your letter of February 8 with regard to the price of dulcite and adonite. We very much regret that your correspondent has not gone more fully into the matter before making charges against firms who are trying to help British industries at a critical time. We should welcome a visit from your correspondent as he may not know the difficulties which have been experienced in obtaining the raw material for the manufacture of dulcite. Dulcite originally was a by-product, and was sold at 4*s*. 6*d*. per oz. The price before the war rose in stages from 4*s*. 6*d*. to 15*s*., then to 25*s*., then to 35*s*., and finally to 45*s*. per oz., which was the price ruling on August 1. We had at that time only a small stock of both dulcite and adonite, consisting of about 8 oz. We purchased a further supply of both these chemicals on or about August 18, but at considerably advanced prices, the supplies being obtained from wholesale chemical merchants in this country. We thereupon raised our prices to 100*s*. per oz. in the case of dulcite and 36*s*. per oz. for adonite; this gave us the same rate of profit as we had obtained from dulcite and adonite before the war.

This supply lasted us until December, when we were able to obtain a very small quantity of these two chemicals from small laboratories who had gone to the expense of manufacturing, and the prices being considerably advanced, necessitated the selling prices being raised accordingly.

At the present moment we have no dulcite of any description in stock, and have not had for some weeks. The total amount which we had for sale at a higher price did not exceed two ounces.

We have made arrangements with a firm of chemical manufacturers to manufacture for us dulcite and adonite at a price which will allow us to revert to the prices ruling between August and December last, but although delivery has been promised us several times we have not yet received delivery of even ½ oz., and we shall be only too pleased to buy any quantity of dulcite and adonite at the present moment, irrespective of price; our main point is to be able to supply chemicals which are urgently needed, and not to obtain exorbitant profits, and in the case of these two chemicals we may state we have been to considerable expense in endeavouring to obtain the necessary raw material for the manufacture of dulcite and adonite.

A FIRM OF DEALERS IN CHEMICALS.

February 9.

British Supplies of Laboratory Ware.

As chairman of the British Laboratory Ware Association I have had my attention directed to a circular letter issued by the British Science Guild, dated January, 1915, to schools, colleges, universities, and technical institutes, and also to circular No. 885 issued by the Board of Education, dated January 11, 1915, and which I note is referred to in NATURE, page 580, January 21, 1915.

These circulars have been issued under a grave misapprehension, and are likely to give a very misleading idea of the present situation in reference to supplies of laboratory glassware, and I think that it is very important that any anxiety on behalf of the readers of NATURE should be immediately allayed. I therefore beg to place before you the following information:—

The British Laboratory Ware Association, which consists of about 75 per cent. of the apparatus supply firms in the United Kingdom, was formed a few days after the outbreak of the war, in order to co-operate in connection with the production in this country of laboratory glassware, porcelain filter papers, etc., not hitherto produced in this country.

The association is not a ring or financial combine, but is merely arranged for the pooling of information and for saving as much time, and preventing as far as possible duplication of correspondence with works, in the way of inquiries and information; the standardisation of sizes for moulds where works undertake to make; and the elimination of difficulties which would occur if all the various firms were working independently.

So far, after months of correspondence, interviews, conferences, meetings, and considerable expense, the association has solved the problem in connection with glass ware, and in a few weeks' time the various firms constituting the association will be in a position to supply the most useful sizes of glass beakers and flasks in an English-made glass similar to Jena glass, which has been tested by well-known English men of science, and can be definitely and safely recommended.

The same holds good for porcelain evaporating basins, beakers, crucibles, and covers, etc., and also for an English-made filter paper equal to the German quality of Schleicher and Schull No. 595, and further qualities of these filter papers will be forthcoming very shortly. Also, as time goes on, further items will be added to the list, as negotiations are brought to a successful issue.

You will therefore see that a great deal of important and valuable work has been done, and that the problem of glassware has been to a very great extent solved so that an English-made glass equal to the well-known Jena glass will be on the market and can be supplied in a few weeks from the present time by the various firms constituting the British Laboratory Ware Association.

C. A. MERCER,
Chairman of the British Laboratory Ware Association, Ltd.

34 Camomile Street, E.C., London, February 8.

Problems of Radiation.

THE study of the production of homogeneous Röntgen radiation reveals some of the most interesting and suggestive facts bearing upon the problems of radiation. A few of these will be briefly indicated.

The emission of a fluorescent X-radiation by an element exposed to a primary X-radiation of shorter wave-length necessitates the absorption of a greater amount of energy from the exciting primary beam. It is possible definitely to assign a given portion of the energy absorbed from the primary beam as connected with the emission of a particular fluorescent radiation (Barkla and Sadler, *Phil. Mag.*, 1909.) The element exposed to this primary radiation emits also a corpuscular radiation, a portion of which is definitely associated with each fluorescent X-radiation. From measurements of these associated quantities, certain broad conclusions have been found to hold at least approximately in all cases hitherto dealt with; they hold within the limits of experimental error in the one case carefully investigated. These are:—

(1) The number of quanta of fluorescent X-radiation emitted is equal to the number of high-speed electrons in the corpuscular radiation (the associated corpuscular radiation).

(2) The total energy in the corpuscular and fluorescent radiations is equal to that of the primary beam absorbed.

These are not merely hypotheses which by trial may be found to be consistent with quantitative measurements of the energies of the two secondary radiations, but are the only rational conclusions which can be drawn from experiments on *some* substances. The deviations which have been observed in other cases are subjects for further investigation; the nature of these will be indicated later.

These conclusions may be described in greater detail as follows:—

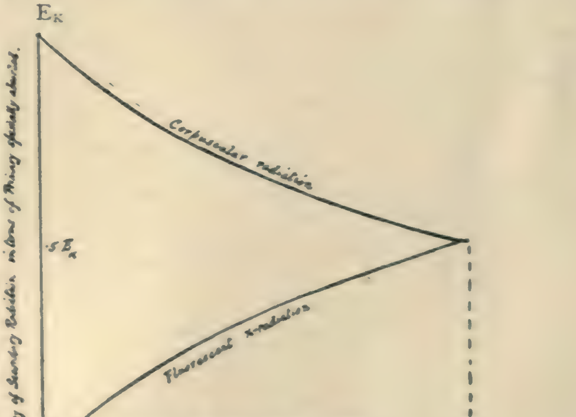
If a primary Röntgen radiation of wave-length μ_1 fall upon an element with a characteristic radiation of wave-length μ_2, then provided μ_1 is less than μ_2 the primary radiation is specially absorbed, and the element emits the particular fluorescent X-radiation, together with an associated corpuscular radiation. If we denote the energy of the primary specially absorbed in connection with the emission of the fluorescent radiation (of Series K, say) by E_K, the energy of the associated corpuscular and fluorescent radiations by C_K and F_K respectively, then $E_K = C_K + F_K$. Also as the energy of each electron in the corpuscular radiation is approximately (possibly accurately) that of a quantum of the primary radiation (we make the usual assumption here, that there is only one velocity of ejection; good reason can, however, be given for this):—

$$\frac{F_K}{C_K} = \frac{\text{energy of fluorescent radiation}}{\text{energy of corpuscular radiation}} = \frac{\text{energy of quantum of fluorescent radiation}}{\text{energy of quantum of primary radiation}} = \frac{\mu_1}{\mu_2}$$

hence:—

$$C_K = \frac{\mu_2}{\mu_1 + \mu_2} E_K \text{ and } F_K = \frac{\mu_1}{\mu_1 + \mu_2} E_K$$

So we obtain expressions for the energies of fluorescent radiation (series K) and the associated corpuscular radiation in terms of that of the specially absorbed primary energy, for primary radiation of any wave-length. Plotting energies of secondary radiations and wave-length of primary radiation, we get the curves shown in the accompanying diagram:—



Thus when μ_1 is just less than μ_2, the energy is equally divided between the corpuscular and fluorescent X-radiations. As μ_1 diminishes a greater proportion of the energy goes into the corpuscular radiation, and less into the fluorescent, until for very short waves all the energy is taken up by the corpuscular radiation.

The above simple theory agrees exceedingly well with the experimental results obtained with the element bromine—the one on which the most trustworthy data have been obtained. Instead of the fluorescent radiation in the particular case carrying away 50 per cent. of the energy of the primary radiation specially absorbed, experiments indicate about 47 per cent. and approximately an equal value for the corpuscular radiation. But there is evidence that with elements of higher atomic weight a limiting value of about 50 per cent. would be obtained. The indication of such a limit gives strong support to the whole theory. On the other hand, from an element of low atomic weight, the experimental value for the fluorescent radiation comes below 30 per cent., and there are indications of even lower values.

It would, however, be remarkable if such a simple theory gave perfect agreement for all elements, and correspondingly all X-radiations. The facts indicated appear of fundamental importance; deviations—real or apparent—will receive investigation and discussion later.

Other important conclusions based on the investigation are that the absorption by an atom is not necessarily in whole quanta of the primary radiation; we have evidence of absorption of primary radiation in quantities of any magnitude between one and two quanta of the primary radiation, or just possibly in fractions of one quantum.

The transformation of primary radiation into fluorescent radiation in certain cases at least is accompanied by little, if any, appreciable loss of energy within the atom.

The energies of X-radiations differing widely in penetrating power are approximately if not accurately proportional to their total ionising powers.

Details of these investigations will be published shortly. C. G. BARKLA.

Physical Laboratory, The University,
Edinburgh, February 8.

The Green Flash.

So much has been written about the green-ray at sunset that I am somewhat diffident about adding anything. But as I find myself unable to accept the orthodox explanation of the phenomenon usually seen I write this note. This phenomenon, as seen by me on several occasions during the last summer on my way to Australia, always consisted in the last segment of the red sun before disappearance becoming a bright green (without any transition through intermediate tints); this green was as nearly as could be judged the complementary to the red of the sun itself. On one occasion I shut my eyes immediately after the green tint appeared, and it *remained visible*. There could be no doubt that what I saw was the purely subjective after-image of the disappearing segment of the sun. Of course, if this is so, it should be easy to set up a laboratory experiment to imitate the natural phenomenon; and on returning I asked Mr. E. Talbot Paris, research student in this department, to arrange an experiment in illustration. An eccentric hole was made in a disc mounted on an axle. Red glass or gelatine film was fixed over the hole, and a bright light placed behind illuminated the film and produced thereby a miniature sun, which by slow rotation, could be made to "set" behind an interposed card. At the instant of setting, the artificial sun exhibited an exact reproduction of the phenomenon of the green-ray. It was easily possible in this way to obtain a red-ray using a green sun, or a blue-ray with a yellow sun, and so on.

It is easy to give the rationale of the effect. The positive light gradually diminishes as the artificial sun passes below the horizon; and it only requires a little adjustment of the rate of disappearance in order that the negative after-image excited at a previous instant when the segment was brighter, shall overpower the simultaneous weaker positive image of the remaining segment itself.

It would not be fair for me to dogmatise and assert that this is the only phenomenon which comes under the head of the green-ray. But it is certainly the only one which I succeeded in seeing; and *it must always be present even on the possible rarer occasions when colour changes arising from dispersion are also evident.* It is certainly also what many others saw. At the same time, it must be added that the phenomenon as observed by different persons, even on the same night, was so variously described as to lead one to suppose that the subjective element is sometimes present to even a greater degree than is implied in the above note. ALFRED W. PORTER.

Physical Department, University College,
London, February 7.

Trenching Ground and Spraying Potatoes.

IN the notice in NATURE, of February 4, of the fourteenth report of the Woburn Experimental Fruit Farm it is suggested that the negative results obtained by us in bastard trenching might have been different had we experimented on vegetables, instead of fruit trees. No doubt the suggestion is correct; and a chance observation last year gave a striking illustration in point. Brussels sprouts were grown in a piece of ground partially occupied by trees; the ground had all been dug, but there were four patches of about four square yards each where it had been practically trenched, by the removal of trees and the digging out of their roots. In each of these patches the sprouts were two to three times larger than those in the intermediate dug ground. Universal experience indicates that a good depth of rich soil is essential for successful vegetable growing; this can only be obtained by trenching and liberal manuring, and nothing in our results should be taken as discountenancing such a practice.

It is also suggested that we should accumulate results on potato spraying to see whether such treatment pays on the average. We are doing so, and those already obtained are nearly sufficient for the purpose. They extend over eight seasons, and are on a fairly large scale, though the diversity in conditions, adopted for other reasons, renders it somewhat difficult to deduce a fair average from them. As it stands, this average is 7·8 per cent. increase on the weight of sound tubers as a result of spraying. Putting the average yield at 7 tons to the acre, and the net price realised at 3*l*. 10*s*. per ton, the value of the increment will be 1*l*. 18*s*. Two sprayings would cost, for materials, labour and use of plant, about 18*s*. to 1*l*. 13*s*., according to the substance used, and this would leave a margin of profit of from 5*s*. to 20*s*. per acre.

SPENCER PICKERING.

Harpenden, Herts.

Early Representations of the Giraffe.

THE discussion in NATURE during the past year concerning the first mention in literature of the opossum and kangaroo has suggested a similar inquiry with regard to certain other well-known animals of the New and Old World.

When one examines into the sources whence were derived the illustrations in early printed books on natural history, it is found that many are copied after drawings in old manuscripts.

A good example is furnished by Conrad Gesner's figure of an ichneumon, taken from an ancient MS. of Oppian, as the author declares.

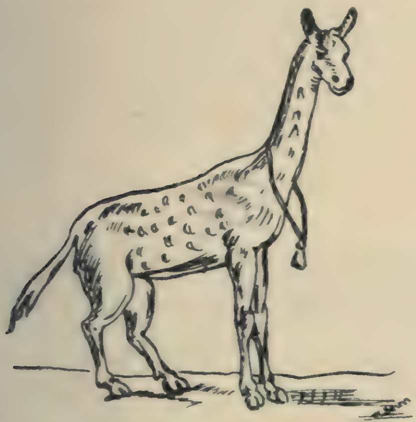


Fig. 1.—Giraffe from mural painting at Villa Pamfili, near Rome. (After Keller, from Jahn).

In the case of the giraffe, what is thought to be the earliest portrait taken from life and engraved in a printed book, occurs in a work published in 1486 by Bernard de Breydenbach, a canon of Mayence, under the title of "Opusculum sanctorum perigrinationum." The figure is, however, inferior to those of the same and other African mammals which are introduced in the Ebsdorf and Hereford maps of 1282.

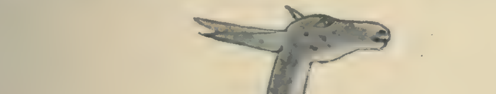


Fig. 2.—Giraffe and Cercocebus, from ancient Egyptian monument at Thebes. (After Ehrenberg).

Pictorial representations of the giraffe by Roman artists have been preserved from the time of classical antiquity, and still earlier designs have come down to us in the form of ancient Egyptian hieroglyphics and inscriptions. That some of these were remarkably faithful likenesses may be judged from the two accompanying figures, one of which is reproduced from O. Keller's "Die antike Tierwelt" (1909), and the other from a memoir by C. G. Ehrenberg, "Ueber dem Cynocephalus und den Sphinx der Aegypter," published in 1834. C. R. Eastman.

American Museum of Natural History.

The Economic Status of the Blackcap.

Mr. Collinge does not meet the question whether the good the blackcap does in the spring balances the value of the fruit it takes in the summer. But he mentions having found a few aphids in the stomachs even in the fruit season, from which it may be inferred that more would be eaten, when there was no fruit in the spring. Now considering the enormous reproductive powers of the female aphis and that every female destroyed in the spring represents a diminution of many hundreds of the most mischievous pests that the farmer has to contend with in the summer, it seems only reasonable to conclude that the bird does *at least* as much good as harm. But the latter is seen while the former is not.

Alfred O. Walker.

Ulcombe, Kent, February 5.

My experience of the blackcap is that the good it does in the spring by no means balances the harm it does during the rest of the year in fruit-growing districts.

The aphids found in the stomachs were all pea lice (*Macrosiphum pisi*, Kalt.), and were probably obtained accidentally when feeding upon peas.

I have elsewhere pointed out (*Journ. Board Agric.*, Sept., 1912) that all birds, other than doves and pigeons, feed their young upon an animal diet, of which insects form a large proportion, whatever may be the character of the food of the adult; the blackcap would, however, seem to form an exception, judging from the four nestlings I examined, whose stomach contents consisted of seeds or remains of fruit and fruit pulp. Walter E. Collinge.

8 Newhall Street, Birmingham.

The Rusting of Iron.

I do not know if any account of experiments such as the following on the rusting of iron has appeared in print before, but if not they may be of interest to others of your readers besides myself. Briefly, they are as follows:—

(*a*) A small flask (100 c.c. flask with long narrow neck does well) is filled to the bottom of the neck with potassium ferricyanide solution, and then the neck is filled to the top with ordinary water. A long bright iron nail is then suspended in the water without disturbing the ferricyanide solution, and in a few minutes a blue colour will make its appearance in the neighbourhood of the boundary between the water and the ferricyanide. The formation of Turnbull's blue goes on regularly, and it settles to the bottom instead of iron rust.

(*b*) A bright iron nail is placed at the bottom of a solution of potassium ferricyanide in a similar flask, and in a short time spots of blue make their appearance on the nail instead of the usual deposit of iron rust.

The explanation according to the ionic theory seems obvious. E. J. Sumner.

The Grammar School, Burnley, Lancs, February 5.

STAR CLUSTERS.

OF all the telescopic objects in the sky none are more beautiful or more fascinating than the condensed, globular star clusters. Their bewildering complexity renders them unsuitable for direct study at the telescope, but photography has now brought them within the range of systematic investigation. The technical problem which they present is by no means easy, and demands high resolving power for success. The fine examples reproduced herewith, M3 and M13, have been very kindly sent from the Mount Wilson Solar Observatory, and illustrate admirably the work of the famous 5 ft. mirror constructed by Mr. G. W. Ritchey.

Considerable attention was given to the star clusters by Sir John Herschel, whose attempts to depict them by hand met naturally with small success. Certain curious irregularities which he believed to exist in the distribution of the stars may be attributed to a purely subjective origin, or they may be accounted for by the absorptive influence of external dark nebulous masses. No great importance is now attached to them, and in the main the stars may be considered as distributed with radial symmetry. But one curious feature noticed by Sir John Herschel has been confirmed by later study. The stars in a cluster tend to divide into two classes of magnitude, a brighter and a fainter, separated by a distinct interval. Can this be a visible division of stars presumably at the same distance and of nearly equal age into the two classes of giant and dwarf stars inferred by Hertzsprung and H. N. Russell?

About twenty years ago Prof. S. I. Bailey, at that time at Arequipa, devoted considerable study to photographs of the chief globular clusters. His work proceeded on two lines. On one hand he made systematic counts of the stars recorded, thus laying the foundation for statistical investigations of their arrangement in space. And on the other he investigated the magnitudes of the stars, and was thus led to the remarkable discovery that several clusters contain a high proportion of variable stars, a ratio of 1 in 7 in the extreme case of M3. His detailed results for the clusters ω Centauri and M3 have been published in two beautiful memoirs. The type of variation is of a distinct character, though a few isolated examples have been found elsewhere in the sky, with a period of about twelve hours and a rapid rise to maximum. In the case of M3 the variation is singularly true to one type, the range between maximum and minimum being two photographic magnitudes. Some clusters, notably M13, are almost entirely devoid of such variables; where they do occur they are apparently confined to the stars of the brighter order of magnitude.

The question of the distribution of stars in clusters was discussed by Prof. E. C. Pickering. Using counts on the clusters ω Centauri, 47 Tucanæ and M13 (Herculis), he formed the important conclusions: (1) that the law of distribution is essentially the same for different clusters, (2) that the bright stars and the faint stars of a cluster obey the same law. He represented graphically the curve of apparent (projected) density for different distances from the centre, and attempted without success to reproduce it by assuming laws of the form $1-r^2$ and $(1-r)^n$ for the density in space. The latter form was also tested by Mr. W. E. Plummer with much the same result on an extensive series of measures of the stars in M13.

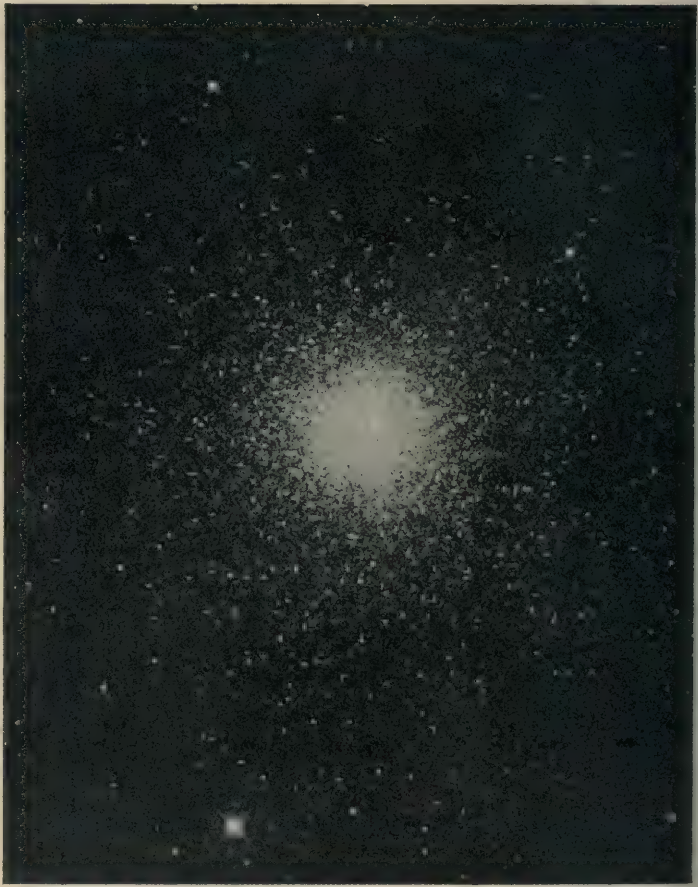


FIG. 1.—M3 Canes Venatici. Exposure 4h.

The next important contribution to the subject is due to H. v. Zeipel, who measured the positions of the stars in M3 (Can. Ven.). By adapting the solution of a certain integral equation studied by Abel he showed how the law of distribution in space may be deduced numerically from the observed distribution as it is seen in projection. Later he compared the law of density in space arrived at in this way with that which obtains in a gravitating spherical mass of gas in isothermal equilibrium. The result represents the density of the cluster satisfactorily near the centre, but in the outer regions the cluster is less dense than the theory requires.

The physical conception thus introduced suggested other possibilities. A sphere of gas in adiabatic, instead of isothermal, equilibrium might be chosen as the standard of comparison. A series of states exists, depending on the constant ratio γ of the specific heats of the gas, which have been extensively studied by Lord Kelvin and others. Emden's "Gaskugeln" is a work dealing exhaustively with the subject. In general, the law of density cannot be expressed in finite terms. But there are exceptional cases in which the differential equation possesses a very simple solution. One of these, discovered by Schuster, corresponds to the value $\gamma = 1{\cdot}2$. Here the law expressing the density at the distance r from the centre takes the form:

$$3a^2N/4\pi(a^2+r^2)^{5/2},$$

where N is the total mass or number of stars. This is finite, although the distribution extends to infinity. If a finite boundary be expected it is impossible to fix one by the counts, and attempts to do so have been proved illusory by the occurrence of characteristic variable stars beyond the supposed limit. However this may be, a comparison of the law with Bailey's counts of the ω Centauri cluster showed immediately an agreement within the limits within which radial symmetry is observed. I next compared the law with Pickering's curve of the projected densities, based on the clusters ω Centauri, M13 and 47 Tucanæ (bright and faint stars treated separately). The accordance was again excellent, and left little doubt that the law represented much more than a mere formula of interpolation. When, however, v. Zeipel's counts of M3 were examined, the outer region was found to conform with the law, while the inner revealed a higher density than was to be expected. As v. Zeipel had, on the other hand, succeeded in representing the central distribution by the isothermal law, it was suggested that the true standard of comparison was a central isothermal core surrounded by an adiabatic envelope, a composite state of equilibrium actually contemplated by writers on the thermodynamics of the subject. Afterwards, by the use of similar methods, Prof. Strömgren proved that M5 (Serpentis) possesses a structure which, whatever the cause, is identical with that of M3. v. Zeipel remarked that the excessive central condensation was more marked among the bright than among the faint stars.

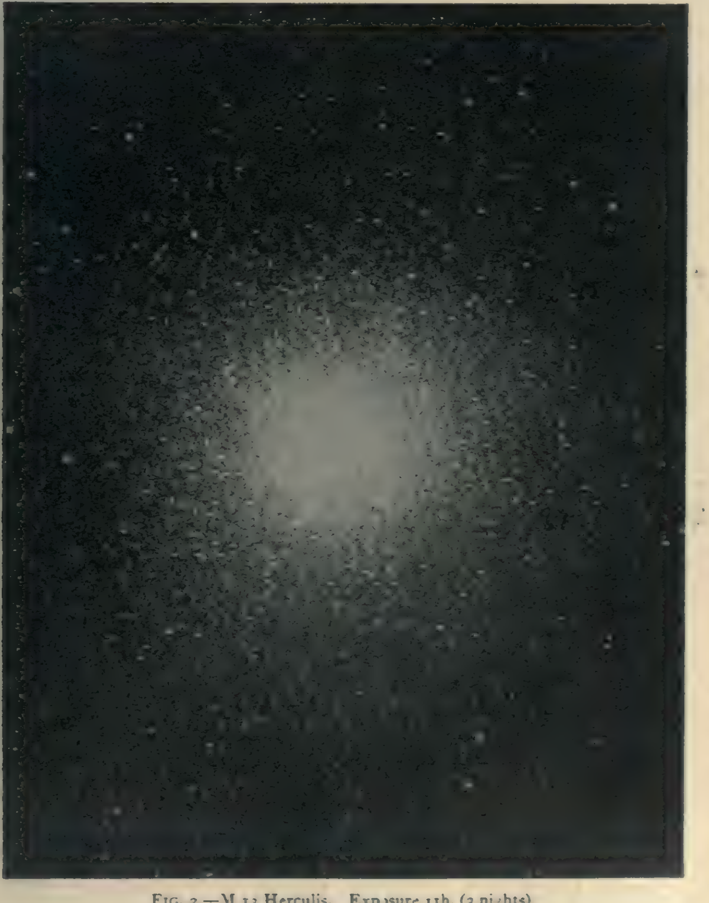


FIG. 2.—M 13 Herculis. Exposure 11h. (3 nights).

The problem has again been discussed by v. Zeipel in an elaborate memoir, using in this instance counts of the stars in M2 (Aquarii), M3, M13 and M15 (Pegasi). He first finds solutions corresponding to these values of γ:

(M2) 1·200, (M3) 1·156, (M13) 1·183,
(M15) 1·179

Thus M2 conforms with the same simple law, which I had found to hold so perfectly for ω Centauri. On the other hand, M3 is again seen to depart from it, and even with the new value of γ the representation is far from good. The law of density here contemplated is a solution of the equation:

$$\frac{d^2(r\rho^{\gamma-1})}{dr^2} + r\rho = 0,$$

and satisfies a physical condition in being regular at the centre. The general solution, however, possesses a singularity at this point, and contains an additional arbitrary constant. Thus the particular law given above is only a special case of the general solution for $\gamma = 1{\cdot}2$, which, as v. Zeipel shows, can be expressed in elliptic functions. Accordingly, he abandons the central condition, and introduces the additional constant which is to be determined, together with γ, for each case. With this modification of the theory the values of γ became:

(M2) 1·194, (M3) 1·198, (M13) 1·203, (M15) 1·197.

so that within the limits of uncertainty in every case the distribution of the stars is consistent with a solution of the above differential equation when γ is assigned the value 1·2.

The analogy between the distribution of stars in a condensed cluster and the density in a spherical mass of gas of a particular type in adiabatic equilibrium thus seems to be fairly established. Even if it be supposed that the cluster is the outcome of an original nebula the question still remains why the distribution of matter should persist long after its condition has completely changed, or why the arrangement should resemble what might be expected of certain vapours (*e.g.*, chloroform). The answer given by v. Zeipel on the basis of a strict mathematical analysis is that this is in conformity with a kinetic theory which applies to an aggregate containing a high proportion of Keplerian binaries. This may be a bold application of the law of large numbers, but it is certainly an interesting conception. Since there is every reason to believe that all short period variables are binary systems the observed occurrence of these in clusters lends support to the view, though they can only represent the exceptionally close systems. The investigations here described refer exclusively to the highly condensed clusters. But there exist also clusters showing states of concentration in varying degree until probably all visible trace of organic connection is lost. In Strömgren's view the whole series represents an order of evolution by which the dense clusters grow out of more scattered forms. Whether the results will throw light on the wider problems of the structure of the sidereal universe seems doubtful in view of certain conclusions drawn by Poincaré, Jeans and Eddington as to the relevance of the kinetic theory. But taken by themselves they present questions of the highest interest which are likely to repay further study.

H. C. PLUMMER.

ON COLOUR SENSITISED PLATES.

I.—IN GENERAL AND ORTHOCHROMATIC PLATES.

IT used to be customary to draw three curves above a diagrammatic spectrum, heat, luminosity, and actinism curves, the last representing the power of light to produce or facilitate chemical change independently of the temperature change. This custom survives to a certain extent, though only one of the curves, namely, the heat curve, is definite. The luminosity curve depends upon the human eye, and eyes vary, sometimes even in the same individual, with regard to their sensitiveness to light and colour. Still, it is possible to draw practically useful luminosity curves in a general sense, and by taking an average human eye, in perhaps almost an absolute sense.

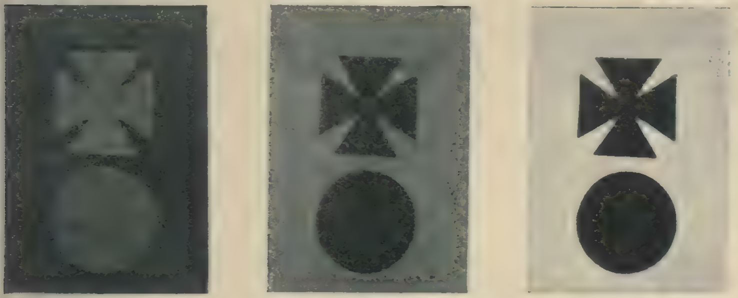
But the "actinism" curve is essentially different, for here we may be concerned, not with a single organ and its possible variations or degrees of perfection, but with every substance that exists on the face of the earth or that can be prepared by artificial means. And if we limit our considerations to the very few substances that are practically utilised in photography, we find that "actinism" extends from well into the infra-red down to the Röntgen rays, which are far below what is generally known as the ultra-violet. "Actinism" extends over a range of eleven or twelve octaves for practical photographic purposes, while luminosity extends over scarcely one octave, and for practical purposes even less than this, and yet some people speak of the photographic plate as colour-blind!

The whole of this eleven or twelve octaves has not yet been dealt with photographically, because in the extreme ultra-violet (the "Schumann region") at wave-lengths a little less than 200 $\mu\mu$, the absorbing power of air and gelatine prevents the passage of radiations through them. But this appears to be due to absorption bands, as radiations of still shorter wave-length (Röntgen rays) pass freely through these media. By getting rid as far as possible of air and gelatine, the photography of the ordinary spectrum has been extended down to wave-length 100$\mu\mu$, or even less. There are other difficulties than the air and gelatine to contend with in investigations of this region, but with these we are not immediately concerned.

Although it is necessary sometimes to bear in mind the enormous range of sensitiveness of photographic materials, even from a purely practical point of view, if we exclude the Röntgen region, and regard only those circumstances that concern the photography of objects, whether terrestrial or celestial, and whether by daylight or artificial light, we have to consider only about two octaves of radiations, or rather more if the far infra-red is taken into account. This range may be still further curtailed when daylight or glass apparatus is used, on account of the absorptive power of glass and the atmosphere, and what remains may often be sufficiently described by indicating five regions, namely, ultra-violet, blue, green, red, and infra-red. The "blue" will include the indigo and violet, and the "red" will include the orange, and the yellow is negligible as in a good spectrum it is represented by little more than the sodium D lines.

In order to photograph coloured objects so that their luminosities shall be correctly represented in the print, we want to get the curve that represents the action of the spectrum on the plate to coincide with the luminosity curve of the spectrum, and then we want a printing method that will preserve these tone values. The alternative of getting equal and opposite errors in the negative and the print so that the one shall correct the other, may have a degree of possibility about it. The fact to be emphasised is that the getting of a correct negative is not the whole business. Indeed, the getting of the two curves to correspond is not the whole business so far as the negative is concerned, for they may correspond at one exposure of the plate to the spectrum and not at another, because the steepness of the gradation of the deposits produced on the plate by equivalent ranges of exposures to the various parts of the spectrum is not the same. These difficulties are mentioned to show that, from a practical point of view, "orthochromatic" or "isochromatic" photography, or whatever it may be called, cannot yet even be regarded as an absolute matter; but where the discrepancy in the use of "ordinary" plates is of the order of a thousand to one, there is plenty of room and need for improvement, before getting, as it were, within sight of perfection.

When the spectrum is photographed on an ordinary plate, the green and red, which are bright to the eye, produce little or no effect; they might as well be black, while the blue and ultra-violet, which are dark and black to the eye respectively, produce a considerable effect, as if they were bright. Similar results are obtained with ordinary objects; slate roofs, being bluish, come much too light; bricks, being red or reddish, come much too dark; grass and green foliage too dark, and so on. The plate is sensitive to all these colours, but it is very much too sensitive to blue, or not sensitive enough to green and red. By causing the light that falls upon the plate to pass through a colour filter that will reduce the brightness of the blue light to about one-thousandth part of its intensity, and increasing the exposure proportionately, the green and red will be given an opportunity to act, and the result will be much improved. To increase exposures to one thousand times the usual length may sometimes be possible (say two minutes instead of the tenth of a second), but the undesirability of such an increase need not be pointed out.



Ordinary Plate. Iso- Plate without screen. Iso- Plate with screen.

FIG. 1.

Dr. H. W. Vogel, in 1873, discovered that by the application of certain colouring matters, it was possible greatly to increase the sensitiveness of plates to green and red light. About ten years later the application of this principle began to be made a commercial matter, and Messrs. Edwards and Co. secured the patent rights in this country. These isochromatic or orthochromatic plates were a great step in advance. The three illustrations (Fig. 1) were prepared many years ago from a design for which the writer was indebted to Mr. B. J. Edwards. The cross and the disc in the original are of such dark shades of blue, that from a distance of from one to three yards, according to the sensitiveness to blue of the eyes of the person looking at the card, they appear quite black, while the ground colour is a bright yellow. On the ordinary plate the yellow comes out darker than the almost black blue. The improvements obtained by using an orthochromatic plate, and then by the use of a colour filter to reduce the blue light in proportion to the yellow, are shown in the reproduction.

There are two or three matters in connection with the use of such means as these to get variously coloured objects represented according to their luminosities that may be pointed out as well from this example as from any other, bearing in mind that they represent general principles. Such plates as these ("ortho-" or "iso-chromatic") are often, if not generally, stated to be sensitive to yellow. This is misleading. Spectrum yellow, as already stated, is negligible in these matters. All objects that are yellow are yellow because they absorb blue, and send red and green light to the eye. Yellow light is a mixture of red and green. These plates have their sensitiveness increased to green and not to red. If, therefore, we so arrange our colour filter as to get full correction for yellow, that is, that yellow and blue shall be correctly represented according to their luminosities, we throw the correction that ought to be borne by the green and red jointly entirely on to the green, and this colour is therefore over-corrected. Greens will therefore be represented too light. On the other hand, the increased sensitiveness does not extend over the whole of the green, it is chiefly in the yellowish-green, and the curve of sensitiveness shows an important depression in the region that may be roughly indicated as being between E and F. Pure yellowish-greens tend, therefore, to be over-corrected on this account also, but what is perhaps of more importance is that a green that comes in this depression of sensitiveness will be under-corrected and come out too dark. This is not a mere theoretical difficulty, for M. Callier, who is a most careful investigator, finds that the green of pine trees largely corresponds to this deficient sensitiveness, while that of grass corresponds rather to the specially sensitised yellowish-green. Therefore these two greens are represented as more different in brightness than they really are.

These facts illustrate the difficulties that result from the fact that specially sensitised plates have not an evenly graded sensitiveness. There is the maximum for the plate, and a new maximum for the new compound introduced. Such irregularity might be compensated by a complex colour filter, but of course only approximately and with much trouble and considerable increase of the necessary exposure.

The "ortho-" or "iso-chromatic" plates of commerce are generally of the type just discussed, and are sensitised by erythrosin or a similar substance. In a second article we shall refer to "panchromatic" plates and other matters.

CHAPMAN JONES.

WHALING IN SOUTHERN SEAS.

MR. THEODORE E. SALVESEN makes a very interesting report[1] on the whale fisheries of the Falkland Islands and dependencies. Whaling in southern seas began, he tells us, with the eighteenth century, the first British fleet of twelve vessels sailing in 1725. They went after sperm whales or cachalots (*Physeter macrocephalus*) and southern right whales (*Balaena australis*), which were harpooned from rowing boats. In the first half of the nineteenth century there were as many as 500–600 whalers so employed—wooden sailing ships, complete in themselves, the blubber being rendered into oil on board. But this kind of vessel is now practically unknown, its place having been taken by the modern steam whaler; and the venue has changed, in the far south at any rate, from sperm whale and right whale to the finners. The sperm whale is seldom met with in the waters round the Falkland Islands and dependencies, its normal habitat being in warmer zones, and the southern right whale is no longer specially sought after, since the price of baleen has fallen so low. Thus attention has been directed to the blue whale (*Balaenoptera sibbaldii*), the largest living animal in the world, to the finner whale (*B. musculus* or *physalus*), to the small fish whale (*B. borealis*), and to the humpback whale (*Megaptera boops*)—all of them often called "finners." As they are more active than the sperm whale and the right whale and only awash for a very short time when breathing, and as they sink after being killed, they were left entirely unmolested in the old days. But now their turn has come.

It was a Norwegian captain, Svend Foyn, who worked out, in the north, about 1866, the method of capturing finner whales, and his devices, with improvements, are now in use by all the modern whaling companies. The whale-catcher is worked by steam, not by men with oars; the whale gun is a finely fashioned cannon; the harpoon carries a shell, the whale line is connected with springs or accumulators; if the whale be not mortally wounded the gunner plays it as an angler his salmon; to keep the carcase afloat it is inflated with air by means of a steam air-pipe from the engine-room! Everything is specialised. And another difference as compared with old days is that the reduction of the carcase is accomplished in a factory on shore or in a large vessel (up to 7000 tons) moored in a harbour.

Floating factory S.S. *Restitution* of North Shields, Possession Bay, South Georgia. From "Report on the Scientific Results of the Scottish National Antarctic Expedition."

Besides the baleen, which no longer pays well or at all, and the oil which is graded into qualities according as it comes from the blubber, the fat of the tongue and kidneys, the flesh and bones, and the refuse, there remains the dried flesh and bones.

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[1] "Scientific Results Scottish National Antarctic Expedition," iv. (1914) pp. 475–486, 10 plates and map.

The absolutely fresh flesh is used to form whale meat meal, a nutritious and wholesome food-stuff, containing 17½ per cent. proteid, largely used for feeding cattle. From the remaining flesh and about a third of the bones whale guano is made; and from bones alone, bone meal.

The modern whaling operations were started by Captain C. A. Larsen in 1904; and his satisfactory results led to the formation of a large number of companies, which now carry on, in the dependencies of the Falkland Islands, the largest whaling business in the world. The season from November 1, 1912, until the end of April, 1913, yielded, at South Georgia, about 5000 whales (52 per cent. humpbacks, about 42 per cent. finners, and about 6 per cent. blue whales). These produced about 200,000 barrels of oil and about 8000 tons of guano. At the South Shetlands and Graham Land the much shorter season yielded also about 5000 whales; at the South Orkneys the still shorter season yielded about 800 whales; at the Falkland Islands only 87 whales were brought in. The total production was about 430,000 barrels of oil—more than half the world's output for that season—and 8375 tons of guano, the gross value being about 1,350,000*l*. sterling. The industry gives employment to about 3500 men. The report is a business-like document, very lucidly presented by one who evidently knows what he is talking about. No indication is given of the probabilities of continuance. We hope that the shortness of the season will suffice to give the finners a chance for many a year to come.

CHEMISTRY AND INDUSTRY.

WE live in an age of specialisation; in no era has the statement that "monomania is the secret of success" approached more closely to the truth. Business is an instinct, chemistry a science, and although it is conceivable that it is of advantage for the chemist to possess some business instinct, and for the business man to have some knowledge of chemistry, the combination in one person of acute business instinct and scientific genius is so rare as to be negligible. Both these great qualities are needed for the solution of our industrial problems—the nation lacks neither the one nor the other, but they reside in different individuals who possess entirely different types of mind. Co-ordination is the sole solution.

It has been stated that the German chemical industries have been built up by men who possess both business acumen and scientific ability. This is not the case. Men of science, such as Caro, Bernthsen, Gläser, and Graebe, and business men such as Brünck, have collaborated, and the collaboration has been successful.

Again, it is remarkable that this country should have adopted the view that there is some essential difference between the scientific chemist and the technologist; the former is dubbed "theorist," and is ignored; the latter is the "practical man," and is belauded. One of the chief reasons for German success lies in the fact that they have realised that the terms man of science and technologist are complementary, that the one must discover while the other adapts.

No chemical process, unless it is based on mere rule of thumb, can be discovered without the aid of the knowledge and experience which can only be gained by many years of scientific training. Such discoveries have to be made and worked out, in the first instance, on the laboratory scale, and this is the province of the scientific chemist. The discovery having been made, and the conditions for production, dictated by considerations of economy, having been determined, it is then the business of the technologist to adapt the process to commercial conditions. It is the lack of a true appreciation of these matters which has hampered the development of scientific industry in this country, especially in those directions in which highly trained specialised knowledge is required.

At the present time many potentially useful discoveries are made in the chemical laboratories of our universities, university colleges, and technical schools, and there are isolated instances in which enlightened manufacturers have made use of them, but in the majority of cases the scientific worker has found by sad experience that little financial profit accrues to him even though he goes to the trouble of obtaining patent protection. He is so rarely a man of business that, if he cooperates with a manufacturing firm, his elimination, from a financial point of view, is usually an easy matter. In consequence, the greater number of scientific chemists, to whom the joy of discovery is everything, and the adaptation of minor importance, prefer to publish their discoveries in the scientific periodicals, where they serve as useful suggestions to others both at home and abroad.

This unfortunate and wasteful condition of affairs can be altered if some body in authority would undertake to organise the scientific ability which is available in our educational institutions. The function of this organising body would be to receive from and to make suggestions to manufacturing firms, and to allot the problems to the scientific laboratories. The scheme would in no way affect the works laboratory, which would still fulfil its proper function of adapting the scientific details to commercial conditions. Moreover, the works laboratory could be recruited from the scientific laboratory, as is the case in Germany, by the enrolment of those men who show themselves fitted by temperament for such work.

It must not be imagined that this article is in any way a plea for the curtailment of research in pure science, which means research of a purely abstract kind, having for its object the discovery of the natural laws underlying the science, and which is, of course, absolutely indispensable. It is merely stupid to decry this form of research or to speak of its apparent lack of utility; if the laws of organic chemistry had not been determined by abstract research there would have been no coal-tar industry.

It is, then, by such a scheme as is here outlined that the scientific army of the nation can be marshalled to meet the present national emergency, but there is yet another aspect which will require immediate attention if we are to carry on the work without unnecessary hindrance.

One of the chief differences between the German and English patent laws is that while in this country a patent specification is held to be addressed to a person skilled in the art, say, to a skilled workman, in Germany it is sufficient if it is understood by an expert. This factor, apart from any intention to deceive on the part of the patentee, is responsible for the frequent "insufficiency of patent specification" which characterises both German patent specifications, as well as British specifications based upon German inventions. It is, indeed, very rare to have a German patent granted on the full text of the specification which was originally submitted to the German Patent Office. The outcome of this is that when the invention has been found novel and patentable by the examiner, the specification is promptly cut down and stripped of all such matter as he considers to be more or less obvious to an expert.

Again, the high cost of legal procedure in this country, and the fact that the Comptroller has no power to refuse the grant of a British patent for alleged insufficiency or want of subject matter, are responsible for the obtaining, particularly on the part of large German chemical companies, of a great number of "block" patents, the whole object of which is to block the development of chemical industry in this country.

It is certain that a good many chemists and chemical manufacturers are fully aware of the fact that a large number of British patents granted to Germans are merely "bluff," and could readily be invalidated were it not for the exceeding high cost connected in this country with such legal procedure; it is for this reason, also, that many small inventors stand absolutely no chance against large companies, which, in view of the high cost, are alone able to go before the Court.

Under Section 27 of the Patent Act an effort has been made to enforce the manufacture of patented inventions in this country by what is generally known as the "compulsory working" clause. It seems to be now admitted that this arrangement has not worked in practice, and its failure is due mainly to the lack of organisation, in this country, of the scientific ability which is vital to all modern industries.

In conclusion, I should add that I am indebted to Mr. J. E. Pollak, of the firm of Messrs. Dicker, Pollak, and Derrimann for the above information respecting the working of the patent laws.

JOCELYN THORPE.

NOTES.

WE regret to see the announcement of the death on January 24, at seventy-six years of age, of the astronomer, Prof. G. F. J. Arthur Auwers, of Berlin, foreign member of the Royal Society and associate of the Royal Astronomical Society.

DR. T. WESLEY MILLS, emeritus professor of physiology, McGill University, Montreal, died suddenly in London on February 14.

THE council of the British Medical Association has decided that the annual meeting, which was to have been held at Cambridge this summer, shall not take place. The statutory annual general meeting of the association, and the annual meeting of representatives will, however, be held.

GOOD progress is being made, says the *Pioneer Mail*, with the scheme for the establishment of a School of Tropical Medicine in Calcutta, with which the name of Sir Leonard Rogers is associated. An excellent site has been secured close to the Calcutta Medical College, and the buildings are in course of erection. The first subscription list shows that a lakh and three-quarter rupees has been obtained already, and another half-lakh is practically secure.

M. LOUIS MOISSAN, son of the late Prof. Henri Moissan, and assistant at the Ecole supérieure de Pharmacie at Paris, who died on the field of battle on August 10, has left to his school, in addition to the scientific estate of his father, the capital sum of 200,000 francs for the foundation of two prizes—one for chemistry (prix Moissan), and one for pharmacy (prix Lugan), in memory respectively of his father and his mother, *née* Lugan.

THE Royal Astronomical Society has taken the first step towards placing itself in line with a number of other scientific societies by deciding at the anniversary meeting on Friday last, February 12, "That this meeting approves of the admission of women as Fellows and Associates of the Society, and requests that all steps necessary may be taken to make their election possible." The meeting was almost unanimously in favour of the proposal—fifty-nine fellows voting for it to three against—and a supplementary charter will now be applied for in order to put the resolution into force.

AT its annual meeting, held in Saint Louis on December 28 last, the Federation of American Societies for Experimental Biology—which includes the Physiological Society, the Society of Biological Chemists, the Society for Pharmacology and Experimental Therapeutics, and the Society for Experimental Pathology—passed the following resolution addressed to the men of science belonging to the nations of Europe now at war:—"That we extend to the scientific men within these nations the hope of an early and enduring peace, which will leave the nations with no permanent cause of rancour towards each other, and which will ensure to each the glories of scientific and humanitarian achievement in accordance with its own conception of these ideals."

THE council of the Royal College of Surgeons has given permission to the Royal Anthropological Institute and Prehistoric Society of East Anglia to hold a combined meeting in the museum and theatre of the college, Lincoln's Inn Fields, W.C., on the afternoon of February 23. Many recently discovered specimens will be shown and discussed, proceedings commencing at 2.30. An evening meeting will be held on the same day in the rooms of the Royal Anthropological Institute at 50 Great Russell Street, W.C., at 8.15, when Mr. Charles Dawson will give a descriptive and illustrated account of the various cultures found in the deposits of the valley of the Sussex Ouse—particularly of the implements recently discovered at Piltdown. Mr. Dawson will also bring forward new evidence bearing on the origin of eoliths, and will exhibit Catalonian silk amulets in the form of prehistoric weapons.

UNDER the auspices of the London Manx Society a meeting was held in the Geological Society's Rooms, Burlington House, on February 13, to celebrate the centenary of the birth of the distinguished naturalist, Edward Forbes. He was born at Douglas, in the Isle of Man, on February 12, 1815, and died at Edinburgh, where he held the University chair of natural history, on November 18, 1854. The president of the Geological Society (Dr. A. Smith Woodward) presided, and addresses were given by Sir Archibald Geikie and Prof. Edward Hull, who had personal memories of Forbes. Sir Archibald Geikie suggested that an Isle of Man Museum might be regarded as a most appropriate memorial of Forbes in the island of his birth, and could be made to include illustrations both of the natural history and of the antiquities of the country. Mr. A. P. Graves added that the associations of Manx literature might also find a place in such an institution. After the meeting the members of the London Manx Society visited the Museum of Practical Geology, Jermyn Street, where Forbes worked for many years as naturalist to the Geological Survey. In the evening, a second meeting and conversazione were held in the St. Bride's Institute.

SEVERAL correspondents have sent us descriptions and sketches of a sun-pillar capped with an arc of a secondary halo, observed during the afternoon of February 11. Writing from Stonyhurst College Observatory, Mr. W. McKeon states that at 0h. 30m. p.m. the ordinary halo of 22° radius was observed, capped by a bright "arc of upper contact," which not only accompanied the halo throughout the whole afternoon, but outlived it by quite thirty minutes. "At 3.15 p.m. a hazy beam of white light began to project upwards from the sun. This gradually brightened and lengthened until by 4.30 it reached the bright arc of contact 22° N. By this time the halo proper was quite faint, while the 'solar pillar' supporting, as it were, the arc of contact, was very bright, and stood out most conspicuously. Just before 5 p.m. the 22° halo had quite vanished, at which time the 'arc' and 'pillar' changed to a strong pink, and continued thus, without the halo, as a most striking object until 5.25 p.m., when both together suddenly faded away." The origins and characteristics of these and related optical phenomena in the atmosphere were discussed in articles in NATURE of June 13, 1912, and April 3, 1913.

"ALDERMAN ARCHIBALD said he did not think the principle was right; it was really a political question." We quote from a report of a meeting of the Middlesbrough Education Committee, at which a circular letter was read from the British Science Guild, asking if a general undertaking would be given to purchase British glass for school laboratory purposes for a period of three years after the war. Seventy per cent. of the public schools represented on the Headmasters' Conference are willing to afford this support to manufacturers contemplating expenditure upon plant for the production of the glassware hitherto obtained mostly from Germany and Austria, but Alderman Archibald suspects that the effort being made to encourage the establishment of these factories is a political move in which the Middlesbrough Education Committee would be unwise to take part. We have fortunately been relieved of the disputes of party politics for the past six months, but apparently the guardians of education at Middlesbrough think that a body like the British Science Guild has been got at by political propagandists, and is trying to forestall legislation of some kind; for the Committee decided without discussion to take no action for the present. Meanwhile the supplies of glassware for laboratories are getting low, and, following Alderman Archibald, nothing must be done to stimulate enterprise in its manufacture here because the attempt to meet an educational want is "really a political question." That an education authority should commit itself to such a view is a pitiful sign of local inability to understand national needs.

THAT the protective treatment against typhoid fever is indeed protective, we all are agreed. Not one man in a hundred thousand disbelieves this plain fact; the only question is whether the treatment ought to be made compulsory. Soldiers take non-compulsion as evidence that the authorities are not sure of the great value of the treatment. "If you believed in it, really believed in it, of course you would make it compulsory." That is the argument; and a very sound argument it is. We may be sure that compulsion would meet with no serious opposition among the men themselves, and would make no appreciable difference to recruiting. Of course, clear instructions ought to be given to all men how to take care of themselves after the treatment. For two days, a man ought to keep quiet; he ought to avoid exposure to the risk of pneumonia; and he ought to leave off all alcohol. If a man, for two days after each of his two doses, will keep quiet, and keep warm, and keep teetotal, he may be absolutely certain that he will have very little trouble from the treatment. All experience, ever since the South African war, has gone to emphasise the danger of direct infection from the surface-soil. It is man who infects men. When the hot weather comes he will have the assistance of swarms of flies; there will be not less typhoid but more. Happily, vast numbers of our troops are already protected; and the "conscientious objector" is likely to feel the "pressure" of his own comrades in the ranks. If the Government adopts some measure of compulsion, it will be a very popular action. It would bring the Government gratitude and censure in the proportion of the sack to the bread in Falstaff's tavern-bill.

THE gold medal of the Royal Astronomical Society was presented, at the meeting of the society on February 12, to Prof. A. Fowler in recognition of his spectroscopic investigations of sunspots, stars, and comets, and related laboratory researches. In a short survey of Prof. Fowler's work, the president, Major E. H. Hills, referred to his association with, and extension of, the study under laboratory conditions, initiated by Sir Norman Lockyer, of various elements represented in celestial spectra. By these means he discovered that many of the band lines peculiar to the sun-spot spectrum are due to magnesium hydride, the existence of which, together with flutings of titanium oxide and calcium hydride, indicate that spots are regions of reduced temperature. This view was further supported by the observation that the "long" lines of the higher chromosphere are generally weakened in sun-spot spectra, while the "short" lines of the lower chromosphere are generally widened or strengthened. The arc spectrum of scandium was shown to consist of two distinct sets of lines which similarly present a differential behaviour in the spectra of the sun, sun-spots, and chromosphere. In the field of stellar spectra, Prof. Fowler proved that the chief substance concerned in the production of the flutings characteristic of stars of the Antarian type is titanium oxide. The tail spectrum of comets was identified by him with the spectrum of carbon monoxide at extremely low pressures—0·01 mm. or less; and during this research a new high-pressure (100 mm.) spectrum of the same carbon compound was discovered. Investigations of spark spectra, and particularly of Sir Norman Lockyer's class of "enhanced lines," led to the discovery of a new ultra-violet series ascribed to "proto-helium," and also to a series of close doublets having the spark-line of magnesium, $\lambda 4481$, as its leader. The bearing of these series upon theories of the constitution of the atom was discussed in the Bakerian Lecture delivered by Prof. Fowler before the Royal Society last year (NATURE, April 9, 1914, vol. xciii, p. 145).

PROF. CARL THEODOR LIEBERMANN, who died on December 28 of last year, at the age of seventy-two, left behind, in his numerous published researches, the record of a remarkably active scientific career. Carl Liebermann was born in Berlin in 1842, and spent the greater part of his life in his native town, first as assistant to Prof. v. Baeyer, and later as professor of chemistry in the Technical College of Charlottenburg. It was in Baeyer's laboratory in 1868 that young Liebermann, with his colleague, Carl Graebe, made the famous discovery of the synthesis of alizarin from anthracene, which, like modern synthetic indigo, revolutionised the colour industry of the time, and brought to a sudden end the cultivation of the natural product. It would be impossible in the course of a short notice to attempt to enumerate the variety of problems in organic chemistry to which Liebermann devoted his long life. Following up his first investigation, he made a comprehensive study of the various hydroxy-derivatives of anthraquinone and the corresponding derivatives of naphthalene (naphthazarin), from which he was led to formulate a theory of coloured compounds and mordants. He included in his researches the study of many natural and artificial dyestuffs, such as brasilin, rhamnetin, quercetin, chrysarobin, cochineal, coerulignone, and a variety of phenol colouring matters, the structure of which he was able in many cases to ascertain. In later years he turned his attention to the alkaloids, especially the numerous constituents of the coca-leaf, which he isolated and studied. Among these constituents he examined cocaine, for which he devised a method of synthesis, cinnamylcocaine, the truxillines, which he also synthesised, and also ascertained the structure of the interesting pair of truxillic acids with which they are combined; benzoylecgonine; tropa-cocaine and hygrine. The latter he also found in Peruvian cusco-leaves, together with cuscohygrine. Prof. Liebermann received the honorary degree of D.Sc. of the University of Leeds in 1906, and was also an honorary fellow of the Chemical Society.

WHEN Columbus discovered and landed on Jamaica during his second voyage, in 1494, he found it populated by Arawak Indians, who, after some hesitation, followed by bribing, received the white men in a friendly spirit. The subsequent settlement of the island by the Spaniards, and the impressment of the natives for work in the gold-mines of Haiti, as well as for agricultural labour in their own island, soon led, however, to their extermination, and by 1558 the whole Arawak nation appears to have been completely wiped out. To recover traces and relics of this lost race has been the self-imposed task of Mr. G. C. Longley, of Pelham Manor, New York, who for the last half-dozen years has passed the winter in the island exploring the old kitchen-middens. The result is a collection of some 1500 celts, fragments of pottery, grinding-stones, stone-pendants, etc., all of which have been presented by the collector to the American Museum of Natural History. They form the subject of an illustrated article by Mr. Longley in the *American Museum Journal* for December, 1914.

A NOVEL kind of nesting-box made of bark in the shape of a slug, so as to be almost invisible when affixed to the trunk or arm of a tree, is described and illustrated in the *Selborne Magazine* for February.

A WELL-MERITED protest against the treatment of horses with the home troops in the early part of their training in certain districts is formulated in the February issue of the *Animals' Friend*, where it is stated that horses taken out of good stables were tethered in the open during wet and cold weather—in some cases even without rugs. Many fine horses, as we can testify from personal knowledge, were utterly ruined, if not actually killed, by such treatment.

IN his annual fish-notes from Great Yarmouth, for 1914, Mr. A. H. Patterson, in the January number of the *Zoologist*, expresses the opinion that the fecundity of the herring is so great as to render it impossible for sea-birds, such as gannets and cormorants, even to reduce, let alone deplete, the shoals that annually visit our coasts. The reduction in the numbers of cetaceans in recent years must also be taken into account, as well as the increasing capture of dog-fishes for food. Nothing can ever exhaust the shoals save the trawl-net, which in a few hours can destroy, in the shape of ova on the sea-bed, millions more potential herrings than those devoured in the adult state by birds in a twelvemonth.

THE most striking photographs in the January number of *Wild Life* are those of the head of a Guinea baboon and of a magnificent cluster of eggs of the large yellow underwing moth. In some instances a moth of that species will lay no fewer than two thousand of these beautifully sculptured eggs, which are at first white, but change to purple before hatching. Another good sample of photography is a badger just peering out from its "sett" beneath the trunk of a giant oak. The writer of the accompanying letterpress, or at all events the editor, should, however, have known that it is quite out of date to refer to the badger as *"Ursus" meles*. Indeed, the practice of introducing the scientific names of well-known animals in publications of this nature is altogether unnecessary.

THE Imperial Department of Agriculture for the West Indies has issued a useful pamphlet (No. 76) dealing with Indian corn (maize). The cultivation, husking, milling, etc., are described in detail, and the insect pests are fully treated with the aid of illustrations. Of these the corn-ear "worm," *Laphygma frugiperda*, is the most serious.

INDIAN Forest Bulletin, No. 26, gives an account of the resin industry in Kumaon, the preliminary experiments for which were carried out by Dehra Dun officers twenty-five years ago. The oleo-resin from the Chír pine (*Pinus longifolia*) is now successfully obtained by methods similar to those in use in the Landes district of France, and 43,000 maunds of crude resin were yielded in 1913–14.

THE buildings of the Forest Research Institute at Dehra Dun are described and illustrated in the December number of the *Indian Forester*. The buildings just completed consist of a main research institute in which the fine library is housed, a chemical laboratory with a separate distillery and separate gas-house, workshops for the economist and entomologist, an insectary, and a students' laboratory. The buildings are in red brick, uniform in style but unfortunately very far from beautiful.

THE Potamogetons of the Philippine Islands have been examined by Mr. A. W. Bennett, and his account appears in the same number of the *Philippine Journal of Science*. Only one new species is described. The almost world-wide range of some of the species of these aquatic plants is of interest, *P. angustifolius*, for instance, being found in Europe, North America, Cuba, Madagascar, India, China, and Luzon. *P. pusillus* is equally widespread. *P. javanicus* appears to be the only species found in the Philippines which extends to Australia.

IN 1901, amongst 2000 seedlings that were raised from the nuts of a certain black walnut (*Juglans Californica*) tree, growing at Santa Ana, in California, there were found twenty plants with peculiar foliage. The parent tree, which was normal, had large compound leaves, each composed of eleven to nineteen leaflets. The peculiar seedlings bore small leaves, each made up of three leaflets, or in rare cases reduced to a single leaflet. Mr. N. B. Pierce, of Santa Ana, writing in NATURE, September 10, 1914, p. 34, considered this sport to be a hybrid between the Californian walnut and the evergreen oak, *Quercus agrifolia*, which grows in the same region; and the occurrence of a supposed bigeneric cross created a sensation in California. The sport, while interesting, seems merely to be a case of arrested development, exactly similar to that of the simple-leaf ash well known in Europe, and figured in NATURE, January 7, 1915, p. 522. Prof. Babcock, of Berkeley University, has made an elaborate study of this sport, publishing the results in two profusely illustrated bulletins ("Studies in Juglans," i. and ii., Univ. of California, Pub. in Agri. Sciences, vol. ii., 1913, 1914), and comes to the conclusion that there is no evidence of hybridisation, and that the sport does not arise from visibly malformed flowers or fruits. He states that a normal tree has been found which annually produces a small percentage of the trifoliolate form. This is exactly the case with the simple-leaf ash, and the real cause of the arrested development which is present is as yet unexplained.

THE Monthly Meteorological Charts of the Atlantic and Indian Oceans for February, 1915, which have recently been issued by the Meteorological Office, give much detail of interest to the seaman, such as winds, currents, barometric pressure, temperature, and ice. The Atlantic chart mentions that the frequency of fog in February is similar to that recorded since October, and the maximum frequency in mid-Atlantic seldom exceeds 5 per cent., as against 40 per cent. in July. Steamers making the Transatlantic passage in February are not likely to be hindered by fog. Thick weather is, however, commonly experienced from December to February near the African land, due largely to dust blown seaward from the Sahara. Charts of mean salinity and surface temperature are given for the Atlantic and for the English Channel for October, 1914. The isohalines coupled with the sea surface isotherms will be of considerable scientific value with the extension of the period. The Indian Ocean chart has a copious note on submarine seismic disturbances. It mentions that some years ago the late Sir G. H. Darwin, member of the Meteorological Council, pointed out that probably the actual places of origin of earthquake shocks are usually situated under the sea in proximity to a coast. Numerous extracts are given from special meteorological logs kept on board ship, and in these the sensation is commonly described as though the vessel was grinding over a rocky bottom or reef.

IN his address to the physics section of the American Association for the Advancement of Science in

December last the chairman, Prof. A. D. Cole, of the Ohio State University, after reviewing the evidence for the existence of the electronic atom with a central nucleus, expressed the opinion that some such form of atom would soon receive general recognition. He does not, however, think that the details of any of the atomic models at present under discussion can be considered as more than tentative and provisional. The address is reproduced in *Science* for January 15, and gives a clear and readable account of the advances made during the past three years.

THE *résumé* of communications made to the French Physical Society at the meeting on January 15 includes a short account of the automatic apparatus devised by M. E. L. Dupuy for the study of the anomalies in the expansion of alloys with rise of temperature. The nature of these anomalies makes it desirable that a continuous record of the expansion should be obtained, and M. Dupuy has succeeded by means of his apparatus in obtaining records for a number of chrome-nickel steels which go far towards clearing the way for a complete explanation of their behaviour. The new apparatus requires a rod about 7 cm. long of the material to be tested, and a similar rod of silica. The two support a mirror which rotates about a horizontal axis as the lengths of the two rods become different during the expansion. A beam of light after reflection at this mirror falls on a second, which is rotated about a vertical axis as the current from a thermo-junction in contact with the specimen varies. The beam of light is received finally on a photographic plate, and a curve results the abscissæ of which are temperatures and ordinates expansions.

IN a paper entitled "Alchemy and the Devil," by Dr. J. B. Craven, Archdeacon of Orkney, read before the Alchemical Society on February 12, attention was directed to the close association which existed in the eyes both of the Church and the people between alchemy and magic, and the stern disapprobation with which such arts were viewed, as aiming at gaining the pleasures of wealth and the senses by demoniacal aid. The State joined in this denunciation, and in 1404 the practice of alchemy was made a felony in England. In 1689, however, this Act was repealed, doubtless owing to the saner and more scientific attitude towards nature and the investigation of her secrets then coming to the fore, and culminating in the foundation of the Royal Society. Whilst, in fact, alchemy and magical practices had little in common, many seekers after the Philosopher's Stone were inspired by evil motives—by greed and avarice. But others were true natural philosophers, and there was, Archdeacon Craven suggested, a still higher alchemy, which aimed, not at making material gold, but at the transmutation of the soul's dross into spiritual gold.

ATTENTION may be directed to a paper in which Mr. W. N. Haworth describes a "New Method of Alkylating Sugars" (Trans. Chem. Soc., 1915, vol. cvii., p. 8). This operation has been carried out previously by means of alkyl iodides and silver oxide, two expensive agents which have the advantage of avoiding complications, such as racemisation, the Walden inversion, and the interconversion of glucosides. It is now shown that similar results can be achieved in aqueous solutions and at about one-fifth of the cost by using alkyl sulphates and caustic soda as alkylating agents. In every case where comparison was possible, the optical rotatory power of the product was equal to that obtained by the earlier methods, and it is clear that the easier and cheaper preparation will greatly facilitate synthetic experiments in the sugar series.

THE January issue of the Chemical Society's Journal contains a redetermination of the atomic weight of tin by Mr. H. V. A. Briscoe, working in Prof. Baker's laboratory at South Kensington. It is remarkable that nearly all the previous determinations gave values approximating to 118, with the exception of five series of measurements by Bongartz and Classen, which gave the value 119·0, which has been generally used ever since. Nearly all the early measurements depended on the oxidation of tin to the dioxide or the converse reduction, but it is doubtful whether this oxide is a suitable substance for experiments on atomic weight. On the other hand, all the five methods of Bongartz and Classen depended on weighing tin in the form of an electrolytic deposit on platinum, and would be vitiated by the inclusion of mother-liquor in the deposit. The new measurements now described depend on finding the ratio, $SnCl_4 : Ag$. Fifteen analyses gave numbers ranging from 118·678 to 118·714, and eleven of these fell between 118·690 and 118·711. The atomic weight finally deduced is 118·70, and seems to be worthy of considerable confidence.

THE well-deserved popularity of the two-cycle hot-bulb, or semi-Diesel engine, is directing the attention of designers toward the perfecting of this simple type of prime-mover. Earlier examples of this type were rather uneconomical compared with the four-cycle engine, but this objection has been gradually reduced. In ease of starting, trustworthiness, etc., the hot-bulb semi-Diesel engine has undoubted advantages over some other forms. *Engineering* for February 12 has illustrated descriptions of an engine of this type made by Martin's Cultivator Company, Ltd., of Stamford. The engine illustrated gives 9 brake-horse-power at 475 revolutions per minute, and has a single cylinder 7 in. diameter by 8 in. stroke. Scavenging air is compressed in the crank-case. The engine is started by a blow-lamp, and will start in about three minutes from cold on crude oil, and in five minutes on paraffin. Regulating and governing are effected by varying the stroke of the fuel-pump. There are many points in the design of this engine which should make for trustworthiness in working and freedom from break-down.

THE *Engineer* for February 12 contains an illustrated description of the construction of the new Mappin terraces at the Zoological Gardens in Regent's Park. The area covered by the terraces and hills takes the shape of a quadrant, and measures about

10,000 square yards. The hills are about 70 ft. high, and have an area of about 39,000 square feet; these are made in reinforced concrete about 3 in. thick. The lower terraces where the heavier animals are quartered have thicknesses varying from 5 to 7 in. No two square yards of surface are alike. The entire area was divided into squares of approximately 7 ft. side by radial and concentric lines. Contours along each of these lines were drawn, and these, together with a plaster model, enabled the scaffolding and centering to be erected. Timber being out of the question for the centering on account of the irregularity of the surface, a simple and effective substitute was found in wire netting having a fairly small mesh. By mixing the concrete fairly dry, very little escaped through the meshes. The whole is supported on reinforced concrete columns; very wide and shallow beams span the columns in both directions, and are embodied in the thickness of the slabs which form the surface of the terraces and hills. The work was completed in thirteen months.

MESSRS. JOHN BARTHOLOMEW AND CO., of the Geographical Institute, Edinburgh, have published a new and revised edition of their "Route Chart of the World," which is sold at 1*s*. on paper, and 1*s*. 6*d* on cloth.

THE Proceedings of the third International Congress of Tropical Agriculture, held at the Imperial Institute at the end of June last, have been published by Messrs. John Bale, Sons and Danielsson, Ltd., in one volume, at the price of 10*s*. net. An article describing the meetings of the congress was published in the issue of NATURE for July 9, 1914 (vol. xciii., p. 489). The volume has been edited by the honorary secretaries of the congress. It runs to 407 pages, and includes abstracts of the papers supplied by the authors, reports of the discussions, and the address of the president, Prof. W. R. Dunstan. More than 150 papers, coming from authorities in fifty different countries, were presented to the congress, and the principal problems connected with tropical agriculture were dealt with.

AMONG the forthcoming books of the *Oxford University Press* are the following:—In *Anthropology*:—Aboriginal Siberia · a Study in Social Anthropology, M. A. Czaplicka, illustrated; Contributions to the Ethnology of the Salish Tribes, J. A. Teit; Lower Umpqua Texts, L. J. Frachtenberg. In *Biology*:—Heredity and Environment, E. G. Conklin. In *Geography*:— Historical Geography of South Africa, Sir C. Lucas, part ii., from 1895 to the Present Day; Geography of Eastern Asia, D. Paton; The Voyages of the Norsemen to America, W. Hovgaard (Scandinavian Monographs, vol. i.). In *Medical Science*:—The Evolution of Modern Medicine, Sir W. Osler. In *Miscellaneous* publications:—Scientific Management, C. B. Thompson; Architectural Acoustics, W. C. Sabine.—The *Cambridge University Press* announces for early publication the following volumes in the "University of Chicago Science Series":—The Origin of the Earth, Prof. T. C. Chamberlin; The Isolation and Measurement of the Electron, Prof. R. A. Millikan; Finite Collineation Groups, Prof. H. F. Blichfeldt.—*Henry Holt and Co.* (*New York*) announce:—The Functions of the Nervous System and the Special Senses, R. P. Angier; General Zoology, Prof. E. G. Conklin; Economic Zoology and Entomology, Prof. V. L. Kellogg and R. W. Doane; Industrial and Commercial Geography for High Schools, Prof. J. R. Smith: College Text-book of Botany, Prof. D. S. Johnson.

OUR ASTRONOMICAL COLUMN.

A NEW COMET, 1915*a* (MELLISH).—A telegram from Prof. Strömgren, Copenhagen, received at the Royal Astronomical Society on February 12, announces the discovery of a small bright comet by Mr. J. E. Mellish, of Madison, Wisconsin, U.S.A., in the position R.A. 17h., declination 3° N., and moving slowly east. A further telegram received on February 16 announces that on February 14 the position was R.A. 17h. 7m., declination 2° 54′ N. The comet is thus in Ophiuchus, and rises about 2 a.m., so that it should be visible in a small telescope between that hour and daybreak.

THE ZODIACAL LIGHT.—Those who are in a position to make observations of the zodiacal light will find some very useful information in the notes on this subject published in the U.S. *Monthly Weather Review* (September, 1914), by Mr. Maxwell Hall. The author describes the chief points which should receive the observer's careful attention, and suggests the best seasons for studying the eastern and western branches. Naturally, low latitudes are best suited for the observation; the fact that no instruments are required, but simply a level terrace and wide expanse of sky should multiply the number of those who observe this interesting and beautiful phenomenon.

ASTRONOMY AND MATHEMATICS.—In an address as vice-president and chairman of Section A (Astronomy and Mathematics) of the American Association for the Advancement of Science, Dr. Frank Schlesinger took as his subject the object of astronomical and mathematical research (*Science*, January 22). The address takes the form of pointing out to the astronomer and mathematician the great need of mutual help, and the tendency of meetings of mathematical and astronomical societies to increase the separation between these two sciences. Dr. Schlesinger directs attention to numerous astronomical problems in the solution of which the help of the mathematician is needed, and takes as an example that which concerns spectroscopic binaries, which offers a rich field.

THE MADRID OBSERVATORY'S ANNUAL FOR 1915.—The Annual for 1915 issued by the Madrid Observatory under the editorship of Prof. Iniguez, is a volume of 703 pages. The first two hundred pages are devoted to tabular statements regarding the ephemerides of the sun and moon, followed by those of planets, satellites, and comets, and facts dealing with eclipses and occultations, together with some numerous useful tables. These are followed by several articles by different authors, among which may be mentioned a long article on time determination, and a preliminary account of the solar eclipse expedition of August last. A *résumé* of the observations of the sun made at the Madrid Observatory during 1913, including spots, faculæ, prominences, etc., is given, concluding with the meteorological observations made during the same year.

WHAT IS GRAVITATION?—"It is scarcely too much to say that the nature of gravitation remains as much a mystery to-day as when the law was first formulated by Sir Isaac Newton." Thus writes Prof. Eddington in one of those excellent articles on "Some Problems of Astronomy," which appear monthly in the *Observatory* (February, p. 93). The article continues as follows:—"In the meantime, theories of matter, of æther, and of electricity have arisen, have held their vogue, and have been superseded by others; but gravitation stands apart from these changing views. No experiment has as yet shown any relation between it and the other phenomena of nature; the simple law, unconditional and universal, has been all-sufficient hitherto. We have grown accustomed to regarding gravitation as something outside the scope of ordinary physical theories. If a new model of the atom is put forward, we ask if it accounts for the Zeeman effect, for chemical affinity, for the dispersion of light, and a host of incidental phenomena; but it would be considered unfair to suggest that it ought to account for the one fundamental and universal property of matter—gravitation." Prof. Eddington then discusses suggestions that have been made concerning possible mechanisms for gravitation, and finally asks the question, "Does gravitation conform to the principle of relativity?" A decisive result of one of the tests, whether it be positive or negative, would, he states, be of remarkable importance, and "a positive result would mean that gravitation has been pulled down from its pedestal, and ceases to stand aloof from the other interrelated forces of nature."

EUGENICS AND WAR.

THE second Galton Lecture, in memory of Sir Francis Galton, born February 16, 1822, was delivered on Tuesday evening to the Eugenics Education Society by Prof. J. Arthur Thomson, of Aberdeen University, who spoke on eugenics and war. Certainties as to the effect of war on the natural inheritance of the race have not yet been established, but some probable risks are discernible. In ancient times, when fighting was the order of the day, a weaker clan may have been literally extirpated by a stronger, as black rat by brown rat; but nation does not exterminate nation nowadays. In ancient times a battle may have been an effective sifting out of the weaker, less nimble, more cowardly combatants; but it is not so now. For the elimination is either fortuitous or in the wrong direction. The finest bodies of men are chosen for the most hazardous tasks, often involving terrible mortality, and the conspicuously brave are particularly apt to be cut off. In modern warfare the sifting tends to be dysgenic.

In the second place, there is in the making and maintenance of the army, in a nation with voluntary military service, a selection of the more chivalrous, the more virile, the more courageous, the more patriotic, and among these there is a mortality high above that of non-combatants, which means some degree of impoverishment of the race. If the number of combatants was small in comparison with that of the non-combatants, the degree of impoverishment might be slight, but if we have in our British population about 6,250,000 men between eighteen and forty-five, and if we have, as we may well have, a fighting force of three millions, the disproportionate mortality among the combatants is likely to be serious. The eugenic safeguard is in the sound nucleus of "fit" and brave men who remain to keep things going, and in the women (though they again are differentially affected in Belgium and Serbia), but it looks as if this war meant for Britain a disproportionate elimination of those whom we can least afford to lose. Darwin's sentence, in reference to the past, is probably true of the present: "The bravest men, who were always willing to come to the front in war, and who freely risked their lives for others, would on an average perish in larger numbers than other men."

In the third place, there can be little doubt that the economies and retrenchments after a great war tend to handicap most severely the more highly individuated members of the community. The highly skilled, whose work is not absolutely necessary, will be pinched most; and they are the salt of the race. On the whole, the tendency of modern warfare is dysgenic.

The second subject of discussion was the Darwinian concept of the struggle for existence, in regard to which there is widespread misunderstanding. As Darwin said, the term is used "in a large and metaphorical sense," to include all forms of the clash that occurs when organisms assert themselves in any fashion against environing limitations and difficulties. The reactions may be competitive or non-competitive, self-regarding or other-regarding, with teeth and claws, or with wits and kindness. It is not doubted that one way in which animals answer back to their difficulties and limitations is to intensify internecine competition; it is maintained, however, that another way, common among the finer forms of life, is to increase parental care or to experiment in co-operation. An extraordinarily large proportion of the time and energy of living creatures is devoted to activities which are not to the advantage of the individual, and it is an inadequately appreciated part of nature's strategy that the types that survive are not only those that sharpen weapons and thicken armour, but also those in which the individual has been more or less subordinated to the welfare of the race. The improbability of war being the saving grace of human history grows upon us.

The third point in the lecture was that since war, *biologically regarded*, is, in spite of all its nobility, heroism, and skill, a reversion to the most primitive and crude form of the struggle for existence, it involves a serious risk of slipping down the rungs of the ladder of evolution. What sowings of dragons' teeth there must be in the terrible struggle of this war; is it weak to be afraid lest by and by the crop that springs from them may include something worse than armed men?

The discussion then turned to the eugenic position in regard to some practical questions. It is possible that the losses of the war, taken along with the falling birth-rate, may move public sentiment to a stronger disapproval of selfish forms of celibacy and to a stronger encouragement of chivalrous marriages. There is patriotism in dying for our country, perhaps also in marrying for her. In regard to the marriage of recruits, more than eugenic considerations have to be borne in mind, but where adequate provision is secured for the possible widows and children, there seems no reason to place obstacles in the way of the marriage of recruits of suitable age and good record. It is for eugenists to scan critically all proposals hurriedly projected to meet crises of war strain, such as putting children at the disposal of the farmer—a doubly dangerous suggestion. To be resisted also is the natural desire to economise in the higher super-necessaries, such as various forms of art, for this means crippling super-men. One of the results of the war is likely to be a freshened enthusiasm for all-round physical fitness, and it must be granted that all improvements of nurture are eugenic as long as it is clearly recognised that veneering does not make bad wood sound. The British temperament has an inherent dislike of coercion, and schemes of compulsory military training are to be looked on with grave suspicion. There is the risk of insidious Prussianising. For the undeniable privilege of being part of civilised Europe and for the undeniable distinction of having been willing—on this occasion—to do the right thing at all costs, we shall have to pay a long price, and it is to be feared that part of this price will be the shelving of eugenic endeavours and our connivance thereat. It may be, however, that facts will give the lie to our fears, and that the impoverishment of the possible parent-stock of the future will be in some measure counteracted by an enrichment of our social heritage—perhaps even by a nearer approach than we have ever known to *positive* peace.

STANDARDISING APPARATUS AND METHODS.

SEVERAL circulars recently received from the Bureau of Standards of the Department of Commerce, Washington, well illustrate the untiring industry to be found in the American public offices. Circular No. 9 deals with the standardising of glass volumetric apparatus such as flasks, burettes, pipettes, pyknometers, and measuring cylinders. The bureau aims at encouraging excellence of quality in such apparatus by co-operating with the makers on one hand, and on the other with the users. To this end the circular describes specifications for the various classes of instruments, and the bureau admits for standardising that apparatus only which conforms to the specifications. It is pointed out in the circular that certain of the demands, such as those regarding the quality of the glass and the process of annealing before calibration, are largely dependent for their fulfilment on the integrity and good faith of the manufacturer. Users can therefore help to secure a high degree of excellence by supporting conscientious makers and giving consideration in the first place to quality, and only secondly to the matter of cost. The circular supplies information on such points as the best design of apparatus, the material, the methods of marking the graduations, the units of capacity employed, and the limits of error allowable. There are also directions for the manipulation of the apparatus during testing; and for those who wish to calibrate their own burettes and pipettes a brief description of the method to be employed is given.

Circulars Nos. 36, 48, and 222 deal respectively with industrial gas calorimetry, standard methods of gas testing, and flame standards in photometry. These are technical subjects, and it would be impossible in any moderate space to discuss or criticise the very numerous points raised in these circulars. It may suffice to refer to the last-named, and to state that the variation of the light of flame standards of light as determined by atmospheric conditions and as observed by different observers, or computed by different empirical formulæ, are discussed at length. It is often questioned whether the illuminating power of gas, for example, is more fairly determined by comparison with a flame standard which itself is affected by atmospheric conditions (moisture, CO_2, pressure), or whether a standard which is independent of these conditions, such as an electric filament lamp run under strictly defined conditions, would not be more correct. As the luminosity of the gas flame itself also is affected by atmospheric conditions, though not identically to the same extent as the flame standards of light, the practice in England is to determine the quality of the gas by reference to a flame standard, and to ignore atmospheric conditions. With an invariable standard of light gas of the same quality would appear to differ more according to the weather conditions than it does with a flame standard, and for this reason if very elaborate corrections are to be avoided the use of the variable standard is considered in this country more appropriate than that of an invariable standard.

Three technologic papers issued by the Bureau are devoted to analytical researches, and deal with the determination of ammonia in illuminating gas, the iodine number of linseed and petroleum oils, and the analysis of printing inks. The first of these, by J. D. Edwards, is of more interest in the United States, where the amount of ammonia in illuminating gas is still subject to control than in the country where no ammonia limits are now in force. It deals with the choice of indicators, effect of carbon dioxide on the titration, errors due to solubility of heads, and to incomplete washing, and the choice of absorption apparatus. Paper No. 37, by W. H. Smith and J. B. Tuttle, deals with the iodine number of linseed and petroleum oils. The main point established is that for the iodine solution used (iodine bromide in glacial acetic acid), and probably for other solutions in common use, the conditions of the experiment must be more rigorously fixed than is now usual. Thus 0·1 gram of oil with 25 c.c. of iodine solution gives a lower iodine absorption figure than when the weight of oil and volume of solution are doubled. For mineral oils the absorption increases with excess of iodine, and there is in this case no tendency to reach a constant value. Paper No. 39, on the analysis of printing inks, by the same authors, gives details of the procedure of analysis adopted at the Bureau of Standards for the separation of oil and pigment, the analysis of each separately, and concludes with remarks on the relation of aniline dyes to paper, and on the accuracy obtainable in the analysis.

GASEOUS EXPLOSIONS.[1]

THE investigation of gaseous explosions is of interest to chemists, physicists, and engineers. The chemist studies the laws of combination and dissociation; the physicist deals with modes and rates of inflammation, variation of specific heat, maximum temperatures attained, and laws of radiation and cooling; while the engineer considers both chemical and physical effects as bearing on the practical operation and thermo-dynamics of the internal combustion engine. He also interests himself in the analogous phenomena of inflammable dust explosions as found in coal-mine and flour-mill accidents. The matters of interest are obviously numerous and complicated, and it is accordingly necessary to limit their consideration to a few points. The points selected will be dealt with as they bear more particularly on the engineering problems of the internal combustion engine. In 1907 the British Association, at its Leicester meeting, appointed a committee of investigation. This committee has been at work ever since, and much light has been thrown by the experiments of its members upon the facts connected with gaseous explosions as occurring in closed vessels and within engine cylinders having moving pistons. It is now proposed to describe some of the work of the committee, dealing first with the phenomena of rising temperature, and secondly with that of cooling after explosion.

When a mixture of coal gas and air is ignited within a strong closed vessel, it is found that the pressure rises rapidly, attains a maximum, and falls relatively slowly. To this rapid pressure rise is due the term gaseous explosion. Such explosions are obtained with mixtures of all inflammable gases or vapours with air or oxygen, and very similar phenomena occur with like mixtures of inflammable dust. The rise and fall of pressure is studied by means of sensitive indicator devices, which produce tracings on a rotating drum.

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[1] Abstract of discourse delivered at the Royal Institution on Friday, January 29, by Dr. Dugald Clerk, F.R.S.

The pressure rise is caused by the formation of flame at the ignition point—in this case an electric spark—and the spread of this flame throughout the vessel increases the temperature of the gaseous contents, and thus increases the pressure, as in a closed vessel the volume remains constant. The rate of pressure rise is thus, broadly, the measure of the rate of the travel of the flame through the mass; and, if it be assumed that maximum pressure is attained when the whole vessel is filled with flame, then it is possible to determine the flame velocity by these measurements.

In these experiments the flame velocity for the weak mixture is about 2 ft. per sec., and for the strong mixture 13 ft. per sec. These velocities are attained in closed-vessel experiments without a moving piston. In actual engine cylinders, where the charge has been introduced at a high speed through an inlet valve, the flame velocity is much higher, and it varies with different types of engine from about 20 to 100 ft. per sec. The cause of this variation for similar mixtures has been the subject of investigation by Clerk and Hopkinson, and it has been definitely proved that the higher flame velocity found in working engine cylinders is due to the residual turbulence of the mixture after compression caused by the high rate of flow into the cylinder through the inlet valve. In some engines the gases forming the charge flow through the inlet valve at a rate as high as 160 ft. per sec. Without this increase of flame velocity in the engine cylinder it would have been impossible to run high-speed engines, such as petrol engines, in an economical manner. At the lower flame velocity of the closed vessel the exhaust valve will be open before the pressure had time to rise. The effect of turbulence within the cylinder is very marked in other respects. The rate of loss of heat from a heated platinum wire to the mass of air in the combustion space of an engine is much greater for any given point of the stroke when the engine is running fast than when it is running slow, and if the charge be trapped, so as to allow several compressions and expansions before measuring the heat loss, the turbulence has so died down that the conductivity diminishes.

Another point of interest in gaseous explosions is found in the fact, predicted by Clerk many years ago, but proved by Hopkinson, that the flame entirely fills the vessel before maximum pressure is attained, that is, the combustion, even in an explosive mixture of gas and air, is relatively slow as the chemical combination approaches completion.

Another point proved by Hopkinson's experiments in a large closed vessel is that at whatever point in the vessel the ignition be started, that point is the point of maximum temperature during the subsequent pressure rise, and at that point the temperature rises about 500° above the temperature of combustion, due to adiabatic compression of the hot gas.

The investigations of Profs. Callendar, Dalby, and Coker by means of platinum resistance thermometers and platinum alloy thermal couples has proved the temperatures attained in ordinary engines to vary from about 1800° C. to 2500° C. The new methods of direct thermometric measurement of the temperature flame have amply proved, however, the general correctness of the older method of deducing mean temperature by pressure change.

The investigations of Callendar, Hopkinson, and David (Prof. Hopkinson's pupil) on radiation are of great importance, and prove that this source of heat loss is only second in magnitude to heat loss by convection and conduction. All the radiation experiments clearly show the existence of an unexpected transparency of flame to its own radiations. The radiation work throws much light upon heat distribution in the rapidly succeeding explosions used in internal-combustion engines.

It was long ago observed by Hirn, Bunsen, and others that the rise of temperature in gaseous explosions could not be calculated from the then assumed specific heat of the constituent gases and the known calorific value of the inflammable gas. The deficit of temperature was found to be about 50 per cent., and many attempts were made to explain this deficit, Hirn advocating the theory of heat loss on the rising line and Bunsen supporting the idea of a limit to temperature due to dissociation. Later, the French observers, Mallard and Le Chatelier, maintained that at least part of the deficit could be accounted for on the assumption of increase of specific heat of the gases. Investigations of the members of the Committee have dealt, not only with the points which have been here discussed, but with all these questions—heat loss on the rising line, specific heat of the constituent gases, heat loss on the falling line, and dissociation of the combining gases.

Specific heat work has been in progress by Clerk, by Callendar and his pupil, Swann, and much of this work has not yet been published. Dissociation has been discussed by Dr. J. A. Harker, Prof. Smithells, and Dr. Bone, and both internal energy and dissociation have been discussed by Hopkinson. Ignition temperatures of gases have been dealt with by Prof. Harold Dixon, and Dr. Watson has studied the nature of the exhaust gases from the petrol engine. Many experiments, too, have been made on the law of cooling and heating of gases under compression in cylinders by Hopkinson, Dalby, Callendar, and Clerk.

As a result of this work, the conclusion has been arrived at that, so far as explosions in internal-combustion engines are concerned, dissociation has but little to do with the limit reached. This limit is partly due to increased specific heat at high temperatures, to heat loss to the walls, and to radiation from the explosion. Varying specific heat and increasing radiation account for most of the deficit. Allowing for all these things, however, it appears now to be established that combustion is not quite complete even at maximum temperature, and Watson's experiments on the spectrum of an explosion flame appear to support this view.

All these matters are still under examination, and it is hoped that in the near future a much more complete knowledge may be gained than at present exists. Much is known in a qualitative way, and some quantitative knowledge has been attained, but much still remains to be done in the way of quantitative determinations of matters at first apparently so simple as specific heat.

CLIMATE AND TREES.

In an article on "Woods and Trees of Ireland," in the *Co. Louth Archaeological Journal* for 1914, Prof. Augustine Henry states that in Ireland, as in Scandinavia, the climate prevailing in neolithic times was drier and warmer than that of to-day. Many facts are adduced in support of this improvement, which in Scandinavia amounted to an increase of 4° F. in the average annual temperature. The occurrence of this optimum climatic period is confirmed by the fact that two species of elm in England are unable now to produce fertile seed.

The English elm produces good seeds freely in the warm valley of the Tagus at Aranjuez in Spain, but not in Madrid on the cold plateau 500 feet higher. In England it invariably reproduces itself by root-suckers. The Cornish elm produces ripe fruit in Brittany. Certain forms of Alchemilla are unable now to produce good pollen, yet form seed parthenogenetically. In the Faroe Isles thirty-six species of plants scarcely ever ripen their seeds; and five species never flower. The question of what plants in Ireland are now in too northerly or too cold a climate requires study in the field.

Much has been written on the Lusitanian flora of Ireland, involving the question how the Arbutus is confined as a native tree to Kerry and Cork, not being indigenous elsewhere in the British Isles. Its nearest station on the continent is near Paimpol in Brittany, where, on the abrupt and rocky slope of the cliff of Trieux, for about one and a half miles, this species is very abundant in a wood mainly composed of oak and mountain ash. It is interesting to note that the Cornish elm (*Ulmus stricta*), indigenous only in our islands in Cornwall and Devon, is similarly met with in Brittany. The English elm (*Ulmus campestris*) is probably also a Lusitanian species, occurring elsewhere than in southern England only in Spain as a wild tree. It appears to have entered England by the Severn valley, crossing over the Cotswolds into the Thames valley, and southwards as far as the Isle of Wight.

Prof. Henry, in addition to giving much historical matter concerning the ancient forests of Ireland, shows how the primitive woods and their remains can be easily recognised by the occurrence in them of a peculiar fauna and flora, which is absent in plantations and in arable and pasture lands. A list is given of these sylvicole animals and plants.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Glasgow.—The following additional examiners have been appointed:—Surgery, Sir Charles B. Ball, Bart.; medicine, Sir Thomas Oliver; physiology, Prof. E. P. Cathcart; geology, Dr. John Horne; zoology, Mr. H. H. Brindley; engineering, Prof. J. B. Henderson; mining, Prof. W. H. McMillan.

Forty-three members of the teaching staff, professors, lecturers, and assistants, are engaged in military service at the present time, and nearly five hundred commissions in the Army and Navy have been granted to students and junior graduates of the University. One, who afterwards died of wounds, received the Victoria Cross.

London.—The Senate has conferred the titles of Professor and Reader in the University upon the following:—*Professors*:—Dr. A. L. Bowley (London School of Economics), statistics; Mr. L. R. Dicksee (London School of Economics), accounting and business organisation; Mr. J. E. S. Frazer (St. Mary's Hospital Medical School), anatomy; Dr. T. M. Lowry (Guy's Hospital Medical School), chemistry; Mr. J. H. Morgan (University College and the London School of Economics), constitutional law; Dr. W. J. R. Simpson (King's College), hygiene and public health; Mr. J. H. Thomas (University College), sculpture; and Mr. G. Wallas (London School of Economics), political science. *Readers*:—Dr. R. W. Chambers (University College), English language and literature; Mr. H. Crompton (Bedford College), chemistry; Dr. J. S. Edkins (Bedford College), physiology; Mr. W. J. Goudie (University College), theory and practice of heat engines; Mr. Major Greenwood (Lister Institute), medical statistics; Dr. R. G. Hebb (Westminster Hospital Medical School), morbid anatomy; Dr. R. T. Leiper (London School of Tropical Medicine), helminthology; Dr. H. R. Le Sueur (St. Thomas's Hospital Medical School), chemistry; Dr. F. S. Locke (King's College), physiology; Miss Sara Melhuish (Bedford College), education; Dr. F. G. Pope (East London College), chemistry; Dr. H. E. Roaf (St. Mary's Hospital Medical School), physiology; Dr. O. Rosenheim (King's College), biochemistry; Mr. J. Henderson Smith (Lister Institute), bacteriology; Dr. J. F. Spencer (Bedford College), physical chemistry; Dr. H. M. Turnbull (London Hospital Medical College), morbid anatomy.

Manchester.—The movement started last year for the establishment of a Radium Institution in Manchester met with a generous response from the public. Thanks to the assistance of public men and the Press, the committee that was appointed to carry out the scheme was able to collect a sum of about 30,000*l*. The radium department was established at the Royal Infirmary, and began work on January 1 in a number of rooms that had been equipped at a cost of 1000*l*., and started with about 800 milligrams of radium metal. The contract for the radium, which cost about 21,000*l*., was fortunately given to an American firm, and its delivery was not therefore interfered with by the outbreak of the war. In order to ensure the maximum efficiency, the Radium Committee, acting on the advice of Sir E. Rutherford, Sir Wm. Milligan, and other experts, took control of the equipment of the laboratories; and the standardisation of the radium was done in the physical laboratories of the University of Manchester. The committee has also drawn up a scheme for the distribution of radium either in the solid form as applicators, or as emanation tubes from the liquid form, to the other hospitals in Manchester and the district. Dr. Arthur Burrows is the radiologist at the infirmary responsible for the administration, Mr. H. Lupton is the physicist in charge, and Sir E. Rutherford acts as consulting physicist to the department.

Oxford.—The Committee for Rural Economy reports that during the past academic year forty-eight individual students worked in the department. The soil survey of the district round Oxford has been continued, and a new research on the nitrogen in peat has been started. The new buildings, erected at a cost of nearly 6000*l*., were completed and ready for occupation in October last. Several papers have issued from the school during the year, including six by Prof. Somerville (Sibthorpian professor), a joint paper by Prof. Somerville and Mr. Harper, and others by Messrs. Harper, Morison, Doyne, Sothers, and Jones. Prof. Somerville continues to edit the *Quarterly Journal of Forestry*.

The annual report of the Delegates for Forestry shows that the number of the students in the department at the beginning of the year 1914 was thirty-eight. This number by the end of the year, in consequence of the war, had declined to fourteen. A visit was paid, under the personal direction of the professor of forestry, Sir W. Schlich, to the Forêt de Lyons, in northern France, and weekly excursions were undertaken to Bagley Wood, where, by permission of St. John's College, a forest nursery and experimental plantations have been established. Here periodical measurements are taken of many species of forest trees. Advice was sought and given in respect of twelve estates aggregating 9322 acres, and other work of an advisory nature was carried out. Valuable research has been performed by Mr. E. A. Speyer, who has now accepted a forestry appointment in Ceylon, and by Mr. W. E. Hiley. The finances of the Forestry School are assisted by an annual grant of 250*l.* from the Board of Agriculture and Fisheries.

THE authorities of the Royal Technical College, Glasgow, may well be proud of the part which members, students, and past-students of the college are taking in the King's service in connection with the war. A list, confessedly incomplete, which has been issued, gives the names of 1023 officers, non-commissioned officers, and men, together with their rank, regiment, or ship, and the last year in college, all of whom have been thus connected with the college, and the names of forty-seven other men serving about whom particulars are as yet unknown.

A COPY of the calendar for the session 1914–15 of the University College of North Wales has been received. The new calendar follows on the same lines as those of previous issues. We notice that during 1913–14 the extension work in agriculture carried out by the college was placed, as regards organisation, on a new footing. In three of the North Wales counties served by the college, advantage was taken of the offer of Government help through the Farm Institute Fund to increase very greatly the sum annually devoted to agricultural instruction and to place the work in the hands of county organisers, appointed by the college, but working under the directions of the county agricultural committees. Special lecturers in horticulture, poultry-keeping, and dairy work are also provided by the college for county work.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 11.—Sir William Crookes, president, in the chair.—Dr. D. H. **Scott**: *Lepidostrobus kentuckiensis,* nomen nov., formerly *Lepidostrobus Fischeri,* Scott and Jeffrey.—A correction. The name *Lepidostrobus Fischeri* having been anticipated by Renault in 1890, it is necessary to give a new name to the Kentucky cone described by Scott and Jeffrey (*Phil. Trans.,* Ser. B., vol. ccv., 1914, p. 354). The fossil is now named *Lepidostrobus kentuckiensis.*—T. **Lewis** and M. A. **Rothschild**: The excitatory process in the dog's heart. Part ii.—The ventricles. (1) The excitation wave appears at the pericardial surface of the dog's heart at times which show no great variation relative to each other; but the distribution of the time values over the surface with such variations as they show is very fairly constant from heart to heart. (2) The time at which the excitation wave appears at the surface is controlled by the length of the Purkinje tract to the endocardium beneath the region tested, and by the thickness of the ventricular muscle in the same region. (3) The excitation wave is not propagated by simple spread from base to apex or apex to base through bands of muscle fibres, as has commonly been held hitherto. (4) The capacity of striated cardiac tissue to conduct appears to be related to the size of the cells composing it and to its load of contained glycogen. (5) The auriculo-ventricular bundle and its branches constitute a system of fibres specially endowed in regard to their arrangement and physiological properties to give quick distribution of the excitation wave throughout all parts of the ventricle.—A. J. **Walton**: The variation in the growth of mammalian tissue *in vitro* according to the age of the animal. Previous work has shown that plasma of animals varies considerably in its value as a medium for the cultivation of tissue. The present experiments were carried out with a view of determining whether these differences were due to the age of the animal from which the plasma was obtained. The tissues and plasma of rabbits were alone used, and the majority of animals were of a known age. Tissues of young and old animals were used and were grown in pure plasma from the same animals. In all cases it was found that the young tissues grew better than the old, but the plasma of the young animal was not nearly so satisfactory a medium as that of the old animals. Hence the best results were obtained when young tissues were grown in the plasma of old animals and the worst results when old tissues were grown in young plasma.

Geological Society, February 3.—Dr. A. Smith Woodward, president, in the chair.—Prof. T. McKenny **Hughes**: The gravels of East Anglia. The author discusses the sources from which the subangular gravels that cover such large areas in East Anglia can have been derived. He points out that their great variety of fracture, colour, etc., proves that they cannot have come directly from the Chalk, or from Boulder Clay derived directly from the Chalk, or from the Lower London Tertiaries, none of which contain subangular gravels but only beds of pebbles, and those mostly of small size. The character of the flints in the gravels indicates that they have been derived from surface-soils which have been winnowed and shifted by soil-creep, rain, and streams, until arrested on the terraces and flats of the valleys. The dry land of Miocene age was the first over which the flints of our gravel-beds could have received that subaerial treatment which they all seem to have undergone.—E. **Anderson** and E. G. **Radley**: The pitchstones of Mull and their genesis. The pitchstones here discussed occur with extraordinary frequency, intruded into the Tertiary plateau-lavas of the eastern portion of the Ross of Mull, as well as in less number in other parts of the island. They fall into two main divisions, distinguished by the absence or by the presence of porphyritic felspars. The petrological characters of these pitchstones, and their more crystalline margins, are such that they seem to warrant the grouping of the rocks under a new type-name, and the name leidleite has been chosen. The porphyritic pitchstones occur as flat or gently-inclined sheets; they also are associated with a more crystalline phase, and have been grouped under the type-name innimorite.

Zoological Society, February 9.—Mr. R. H. Burne, vice-president, in the chair.—E. G. **Boulenger**: An Aglyphodont Colubrid snake (*Xenodon merremii*), with a vertically movable maxillary bone. The vertical mobility of the maxillary bone in snakes had previously been regarded as essentially characteristic of the Viperidæ. Observations on the snake in question, which was recently received by the society from Mr. W. A. Smithers, showed that the mobility of its maxillary bones was so great that the fangs could be not merely erected, but were capable of being thrust forward and sideways, the mechanism being as perfect as in any of the vipers. Mr. Boulenger pointed out that the discovery of a solid-toothed Colubrid with vertically movable maxillæ went a long way towards settling the so often discussed problem of the derivation of the viperine maxillary bone. The author traced the probable evolution of the bone, expressing the opinion that the Viperidæ were descended from the Opisthoglyph Colubrids, and that the old view, recently revived, that they were of Proteroglyph ancestry, must be abandoned once and for all.—Dr. W. **Nicoll**: A new species of liver-fluke from the kestrel.

Mathematical Society, February 11.—Prof. A. E. H. Love, vice-president, in the chair.—G. H. **Hardy** and J. E. **Littlewood**: (i) The zeros of the Riemann zeta-function. (ii) An assertion of Tchebychef.—G. B. **Jeffery**: The steady motion of a solid of revolution in a viscous fluid.—S. T. **Shovelton**: Relations amongst Bernoulli's and Euler's numbers.—W. P. **Milne**: Apolar generation of the quartic curve.

Calcutta.

Asiatic Society of Bengal, January 6.—Maude L. **Cleghorn**: A note on the floral mechanism of *Typhonium trilobatum*. Describes the trap-mechanism of the spathe, by means of which beetles are ingeniously captured at night to ensure cross-pollination. The trap-mechanism of this plant resembles that of the Cuckoo-pint (*Arum maculatum*) in the entrance and exit of the trap being above and at the same opening, but differs from it in the deliberate opening and closing of the passage leading down into the trap. Its floral mechanism does not seem to be so perfect as that of the common Kachu (*Colocasia antiquorum*), but it appears to be an advance on that of the Cuckoo-pint.—F. H. **Gravely**: The evolution and distribution of Indian Spiders belonging to the sub-family Aricularinæ. The Ischnocoleæ found in the Indian Peninsula and Ceylon form a very compact group, probably related to those of other parts of the world through their most primitive species only. It is concluded that the Poecilotherieæ have originated from the Ischnocoleæ as a result of their adaptation to a new environment in the Indian Peninsula or Ceylon, to which they are still confined.

Dublin.

Royal Dublin Society, January 26.—Prof. H. H. Dixon in the chair.—Prof. W. **Brown**: The subsidence or damping of torsional oscillations in iron wires is much less than in nickel wires, and is greater in an alternating magnetic field than in a direct field, whilst the reverse is the case with soft nickel wires. With iron wires when the longitudinal load on the wire is sufficiently increased, the damping curves obtained in the direct and alternating magnetic field are identical. Results are also given for iron wires alloyed with silicon, chromium, and nickel, as well as for two non-magnetic wires.—Prof. H. H. **Dixon** and W. R. G. **Atkins**: Osmotic pressures in plants. V.—Seasonal variations in the concentration of the cell sap of some deciduous and evergreen trees. A series of cryoscopic and conductivity measurements made on the sap pressed from plant organs after treatment with liquid air showed that the greater part of the osmotic pressure is due to dissolved carbohydrates. The concentration of electrolytes in leaves increases with age. A similar increase was not found in the roots of *Ilex aquifolium*. The concentration of carbohydrates fluctuates greatly, and causes large variations in the osmotic pressure. In the leaves of *Syringa vulgaris* it was found that the osmotic pressure rose from the opening of the buds and reached its maximum in August. The leaves of both Ilex and Hedera showed higher osmotic pressures in winter than in summer. The osmotic pressure of the tissues of the roots of Ilex attained its maximum in September.

Paris.

Academy of Sciences, February 8.—M. Ed. Perrier in the chair.—A. **Lacroix**: The existence of grained nepheline rocks in the volcanic archipelago of Kerguelen.—G. **Bigourdan**: Application of the angular comparator to the determination of astronomical refraction and its constant. Details of the proposed method for using the instrument described in a recent paper to measure atmospheric refraction.—Armand **Gautier**: The influence of fluorine on plant growth. In certain rare cases the presence of fluorides in the soil inhibits growth, but in general it has a stimulating effect on growth, flowering, and the formation of seeds.—Ed. **Delorme**: Wounds of the external genital organs.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the second quarter of 1914. Observations were made on seventy-one days, and the results are given in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—E. **Goursat**: A class of integral invariants.—Et. **Delassus**: The theory of unilateral finite linkages.—Léon **Bloch**: The theory of absorption of light in metals and in insulators.—F. **Bodroux**: The preparation of esters. Mixtures of alcohol, water, and formic acid give formates on slow distillation, but formic acid has very slight catalytic power in ester formation from other acids. The mixture of sulphuric and hydrobromic acids obtained by decolorising a mixture of bromine and water with sulphur dioxide is recommended as a catalyst, and details are given of its use in the preparation of propyl and *iso*butyl bromides.—L. **Grimbert** and O. **Bailly**: A method for distinguishing the glycerophosphoric mono-esters and on the constitution of crystallised sodium glycerophosphate.—A. **Sartory** and L. **Spillmann**: The bacteriology of gaseous gangrene. In agreement with the results of Weinberg, Doyen, and Yamanouchi, the authors find present in all cases *Bacillus perfringens* in the gangrene pus. Other organisms are present, but this bacillus appears to be the most important as regards pus formation.—P. **Mazé**: The determination of the rare mineral elements necessary to the development of maize. Boron, aluminium, fluorine, and iodine are necessary for the growth of maize.—Em. **Bourquelot**, M. **Bridel**, and A. **Aubry**: The biochemical synthesis of the β-monoglucoside of ordinary propylene glycol with the aid of emulsin.

BOOKS RECEIVED.

International Association for Tropical Agriculture. Proceedings of the Third International Congress, held at the Imperial Institute, London, S.W., June 23 to 30, 1914. Pp. xi+407. (London: John Bale, Ltd.) 10*s*. net.

A List of British Birds, compiled by a Committee of the British Ornithologists' Union. Second and revised edition. Pp. xxii+430. (London: W. Wesley and Son.) 7*s*. 6*d*.

Canadian Institute. General Index to Publications, 1852–1912. Compiled and edited by J. Patterson. Pp. 518. (Toronto: University Press.) 5 dollars.

Bartholomew's Route Chart of the World, with Inset Maps (Edinburgh: J. Bartholomew and Co.) 1*s*. net.

Practical Mathematics. By A. E. Young. Second Year. Pp. xi+164. (London: G. Routledge and Sons, Ltd.) 2*s*. net.

A First Course in Practical Chemistry for Rural Secondary Schools. By W. Aldridge. Pp. xii+122. (London: G. Bell and Sons, Ltd.) 1*s*. 6*d*.

Practical Heat, Light and Sound. By T. Picton. Pp. xv+151. (London: G. Bell and Sons, Ltd.) 1*s*. 6*d*.

Manuale di Fisica. By Prof. B. Dessau. Vol. ii. Acustica, Termologia, Ottica. Pp. vii+612. (Milano: Società Editrice Libraria.) L.15.

Tables Annuelles de Constantes et Données

Numériques: Données Numériques de Biologie, Biochimie, Chimie Physique Biologique, Physiologie, Microbiologie, Pharmacodynamie. By E. F. Terroine. Pp. xi+20. Cristallographie et de Minéralogie. By L. J. Spencer. Pp. viii+425–446. Radioactivité Atomistique. Electronique et Ionisation. By J. Saphores and F. Bourion. Pp. viii+295–307. Spectroscopie. By Dr. L. Brüninghaus. Pp. viii+165–238. L'Electricité, Magnétisme et Electrochimie. By Profs. P. Dutoit and W. C. McC. Lewis, and Dr. A. Mahlke. Pp. ix+258–417. Art de l'Ingénieur et Métallurgie. By S. L. Archbutt and others. Pp. viii+510–600. (Paris: Gauthier-Villars et Cie.)

The Hydrogenation of Oils, Catalyzers, and Catalysis, and the Generation of Hydrogen. By C. Ellis. Pp. x+340. (London: Constable and Co., Ltd.) 16*s.* net.

Catalogue of Scientific Papers. Fourth Series (1884–1900). Compiled by the Royal Society of London. Vol. xiv., C—Fittig. Pp. 1024. (Cambridge University Press.) 2*l.* 10*s.* net.

The Extra Pharmacopœia of Martindale and Westcott. Revised by Dr. W. H. Martindale and W. Wynn Westcott. Sixteenth edition. In 2 vols. Vol. i., pp. xl+1113. Vol. ii., pp. viii+469. (London: H. K. Lewis.) Vol. i., 14*s.* net; vol. ii., 7*s.* net.

Mathematical Papers for Admission to the Royal Military Academy and the Royal Military College for the Years 1905–14. Edited by R. M. Milne. (London: Macmillan and Co., Ltd.) 6*s.*

The Next Generation. By F. G. Jewett. Pp. xi+235. (Boston, New York, Chicago, London: Ginn and Co.) 3*s.* 6*d.*

DIARY OF SOCIETIES.

THURSDAY, February 18.

Royal Society, at 4.30.—Gaseous Combustion at High Pressures: Prof. W. A. Bone and Others.—The Orbits of a Charged Particle Round an Electric and Magnetic Nucleus; Prof. W. M. Hicks.—The Lunar Diurnal Magnetic Variation and its Change with Lunar Distance: S. Chapman.—Some Temperature Refraction Coefficients of Optical Glass: Lt.-Col. J. W. Gifford.

Royal Institution, at 3.—Struggle of Species: Dr. P. Chalmers Mitchell.

Linnean Society, at 5.—The Action of Light upon Chlorophyll: H. Wager.

Institution of Petroleum Technologists, at 8.—The "Cracking" of Oils, with a View to Obtaining Motor Spirit and other Products: W. A. Hall.

Institution of Mining and Metallurgy, at 8.—Notes on some Gold Occurrences in Ashanti: J. Morrow Campbell.—Some Features in the Mining Problems of the East Witwatersrand Area: W. G. Holford.—Prospecting Tin Land in Malaya: W. B. Middleton.

FRIDAY, February 19.

Royal Institution, at 9.—The Visit of the British Association to Australia: Prof. H. E. Armstrong.

Institution of Mechanical Engineers, at 8.—Annual General Meeting.—Convertible Combustion Engines: A. E. L. Chorlton.

SATURDAY, February 20.

Royal Institution, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

MONDAY, February 22.

Royal Society of Arts, at 8.—Motor Fuels: Prof. Vivian B. Lewes.

Institute of Actuaries, at 5.—Practical Points in Connection with the Formation and Valuation of Pension Funds, with a note on Group Assurances: J. Burn and F. P. Symmons.

TUESDAY, February 23.

Royal Institution, at 3.—Muscle in the Service of Nerve: Prof. C. S. Sherrington.

Zoological Society, at 5.30.—(1) Abnormal Gills in the Starfish, *Porania pulvillus* O.F.M. (2) The Ciliation of Asterids, and the Question of Ciliary Nutrition in Certain Species: Dr. J. F. Gemmill.—The Methods of Feeding and the Mouth-parts of the Larva of the Glow-worm (*Lampyris noctiluca*): Miss Kathleen Haddon.—Descriptions of New Fossorial Wasps from Australia: R. E. Turner.—Notes on a small Collection of Heterocera made by Mr. W. Feather in British East Africa, 1911–12: Lt.-Col. J. M. Fawcett.

Royal Anthropological Institute, Joint Meetings with The Prehistoric Society of East Anglia, at 2.30, at the Royal College of Surgeons.—Papers by members of the Prehistoric Society; at 8.15.—Ouse Valley Cultures: Charles Dawson.

Institution of Civil Engineers, at 8.—The Electrolytic Action of Return Currents in Electric Tramways on Gas and Water-Mains, and the Best Means of Providing against Electrical Disturbances: H. E. Yerbury.

WEDNESDAY, February 24.

Royal Geographical Society, at 8.30.—Africa after the War: Sir Harry H. Johnston.

Royal Society of Arts, at 8.—The Economics of the War: Prof. W. J. Ashley.

Geological Society, at 8.—The Ashgillian Succession in the Tract to the West of Coniston Lake: Dr. J. E. Marr.—The Radioactive Methods of Determining Geologic Time: H. S. Shelton.

THURSDAY, February 25.

Royal Society, at 4.30.—*Probable Papers:* The Effect of the Depth of Pulmonary Ventilation on the Oxygen in the Venous Blood of Man: J. F. Twort and Prof. L. Hill.—The Function of Chlorophyll: Dr. A. J. Ewart.—Contributions to the Study of the Bionomics and Reproductive Processes of the Foraminifera: E. Heron-Allen.—The Influence of the Hydrogen Concentration upon the Optimum Temperature of a Ferment: A. Compton.

Royal Institution, at 3.—Struggle of Nations: Dr. P. Chalmers Mitchell.

Child Study Society, at 6.—*Discussion:* The Care and Development of the Child—from Ante-Natal Period to Five Years of Age. Ante-Natal Period: Dr. G. Eric Pritchard; Infancy: Miss J. Halford; One to Five Years: Dr. D. Forsyth.

Institution of Electrical Engineers, at 8.—Electricity applied to Mining: C. P. Sparks.

FRIDAY, February 26.

Royal Institution, at 9.—Solar Eclipse of 1914: The Rev. A. L. Cortie.

SATURDAY, February 27,

Royal Institution, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

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THURSDAY, FEBRUARY 25, 1915.

ROMAN BIRDS AND AMERICAN POETS.

The Birds of the Latin Poets. By Prof. E. W. Martin. Pp. 260. (California: Stanford University, 1914.) Price 1.00 dollar.

THIS book is a monument of patient industry redolent rather of the midnight oil than of the woods and fields. It is mainly an anthology of quotations from Latin, American, and English poets. As a serious contribution to our knowledge of birds, whether European or American, it is not of great value, and naturalists will find it disappointing. But scholars will find it useful as a dictionary or concordance of Latin birds, and to American nature-poets it will prove a treasury of their own bird-lore. The preface should be read first, to prepare the reader for its defects, which to our mind are serious. "My single year in Europe," says the author, "occupied largely with the technique of our craft, left scant time for woods, meadows, and riverside. Besides, this is the task of years for a finished expert in the birds of Europe."

Not having the latter qualifications, Prof. Martin is driven to illustrating the birds of Virgil and Ovid by those of America—which is unsatisfactory, to say the least. The species are hopelessly confused, and we are seldom helped to identify them.

> "Naturally, in bringing together American and Roman birds, I have attempted no close scientific paralleling of species; I have rather tried to group the birds which have roused similar reactions in the feelings of their poetic observers. Hence Roman nightingales have suggested American mocking-birds and even whip-poor-wills, while larks have been answered by bobolinks and starlings by meadowlarks."

In the lengthy bibliography at the end of the book several British ornithologists are mentioned, but we miss the names of Yarrell and Howard Saunders, and apparently Dresser's monumental "Birds of Europe" has not been used at all.

We must now make some more detailed criticisms. On p. 43 Wordsworth's line, "The tremulous sob of the complaining owl," is quoted under Bubo, the eagle-owl; whereas he is certainly referring to the brown or tawny owl. Nor are we told that he afterwards changed this line into "The sportive outcry of the mocking owl." On p. 68 Tennyson's "many-wintered crow" is the rook, as his next line shows. Why did not Prof. Martin quote it? "Presso gutture," so far from meaning "with clear deep note," means the falsetto love-note of the rook in spring (p. 75). Under Haliæetos (p. 109) no attempt is made to distinguish the sea-eagle from the osprey. The Nisus and Scylla myth is probably simply typical of any hawk that strikes down its prey in the air. Kingsley's magnificent hexameter would have been worth including: "As when an osprey aloft, dark-eyebrowed, royally crested."

On p. 118 we are told that "the swallow is an enemy of bees, which they feed (*sic*) to their young." This is true, but some comment is needed. Was Tennyson right when he changed "bee" into "fly" in the well-known line, "The swallow stopt as he hunted the fly"? There is a beautiful swallow legend on p. 121, which we are glad to see. In the note on p. 240 the house-martin's name, *Hirundo urbica*, is applied to the swallow. In spite of his apology in the preface, we find it difficult to forgive Prof. Martin for illustrating our queen of song-birds with the whip-poor-will and mocking-bird. Moreover, it is the reed-warbler, and not the sedge-warbler, which is called the "mock-nightingale" in England (p. 242). But the note on Ruscinia contains much valuable matter, especially Prof. Pierantoni's remarks about the Italian nightingale and the poplar-tree, which is an interesting confirmation of Georgic iv., 511. After quoting four words from Coleridge on p. 131, Prof. Martin hurries on to something inferior and less relevant. Surely this beautiful passage was worth quoting in full:—

> 'Tis the merry nightingale
> That crowds and hurries and precipitates
> With thick fast warble his delicious notes,
> As he were fearful that an April night
> Would be too short for him to utter forth
> His love-chant, and disburthen his full soul
> Of all its music.

There are several quotations from Tennyson, but we miss his "mellow ouzel fluting in the elm"; and his exquisite line on the ring-dove or wood-pigeon is applied to the turtle-dove. Again, his line, "The fire-crowned king of the wrens," is applied to the common wren; and under the same heading (Regulus) we meet with Gilbert White's wood-wren, which is not a wren at all. Milvus is paralleled with not only kite, but also with hawk, falcon, buzzard, and even eagle. On p. 153 we are told that "the note of the bee-eater is like that of wren and swallow." On p. 197 the same quotation from the "Anthologia Latina" appears, with the remark, "The wren's song is like that of the bee-eater and swallow." What this means we must leave our readers to determine.

Strix is illustrated by "the bat and owl inhabit these." We are not sure that Lowell himself would have recognised this illuminating excerpt from his works. Ulula is said to be "the sceech-owl (*sic*) or possibly the barn-owl." We in England do not know the difference. Here are three consecutive quotations illustrating "The Spring Migration and Spring Song":—

> And new-come birds each morning sing.
> (LOWELL.)
> Two feathered guests from Alabama, two together.
> (WHITMAN.)
> And warmed the pinions of the early bird.
> (THOREAU.)

We will leave our readers to make their own comments. There are a vast number of quotations like these, which seem to be stirred in at random. We believe Prof. Martin's countrymen have a prejudice against Greek, but in our opinion his book would have gained enormously in interest and value if he had included some Greek quotations, or at least translations of them. For instance, Homer's passage on the nightingale is even finer than Virgil's. (See Odyssey xix., 518.)

But "a detailed study of the birds in the English poets is, perhaps, our most immediate need" (Preface, p. 1). Prof. Martin may be glad to see our own Laureate at his best in "Nightingales":—

> Alone, aloud in the raptured ear of men
> We pour our dark nocturnal secret; and then,
> As night is withdrawn,
> From these sweet-springing meads and bursting boughs of May,
> Dream, while the innumerable choir of day
> Welcome the dawn.

We gladly acknowledge that Prof. Martin has done a great deal of hard spadework which will serve as a foundation for future writers. He has written a modest, honest, and very painstaking book, displaying a German thoroughness which we should like to have seen turned to better account. Many of his American quotations are extremely pretty, and it is a pity that his gold should suffer from contact with so much dross. Work of this kind should be done, as he confesses in his preface, "preferably by a native, on the ground; and it may well be the task of some future Thoreau or Burroughs."

T. F. ROYDS.

FACTORY ECONOMICS.

The Modern Factory, Safety, Sanitation, and Welfare. By Dr. G. M. Price. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd, 1914.) Price 17s. net.

DR. PRICE has been for some years the Director of the Joint Board of Sanitary Control in the mantle, costume, and blouse industries in the United States, a new experiment in the sanitary control of an industry by organised employers, organised workers, and representatives of the public. He was also director of the investigations of the New York State Factory Commission in 1912 and 1913, and his previous experience as a sanitary inspector and as practitioner in a crowded section of the East End of New York entitles him to speak with authority on the close relation between factory conditions and industrial health. His book is one which should especially commend itself to employers, his clear style and practical knowledge enabling him to dispense with the technical terms which so frequently deter business men from profiting by scientific studies of health conditions.

The chapter on the rise, growth, and influence of the factory is as good as any history of all industries in all countries in all times contained in thirty-eight pages can possibly be. The coincidence of a great increase of population in England with an alleged increase in occupational mortality, both due to the same cause, does not receive either here or anywhere else the attention it deserves.

The rest of the volume has the freshness and originality which only practical knowledge can give. In a short notice it is only possible to direct attention to the wealth of detailed examination of means of improving factory conditions, and to give a few quotations bearing on questions of pressing importance in the United Kingdom.

With reference to underground bakeries and other employment in cellars, Dr. Price concludes: "Cellars cannot be kept clean as other parts of the house, for they are semi-dark, contain most of the plumbing pipes and fixtures, and are, as a rule, the dumping-ground of the whole house. Cellars are also the natural habitation of insects, rodents, etc., and are also in proximity to breeding-places of flies, which are attracted to the foodstuffs" (p. 50).

The desirability of paying attention to beauty in architecture is urged, but rather from the point of view of the community living in the neighbourhood than of the worker. It must be remembered that money spent on front gardens and outsides of factories does not necessarily guarantee even good surroundings for the workers inside.

Fifty-seven pages with twenty-two illustrations are devoted to the causes and prevention of factory fires. The chapter on factory accidents and safety contains 103 pages and eighty-one illustrations. The estimates quoted of accidents in the United States (pp. 133–4) will not bear cross-examination and would be better omitted. The chapter itself is of the highest value. Attention should be paid to the section on accidents due to the physical unfitness of workers: "Not only should there be a routine physical examination of every worker in every establishment before employment, but there should be a periodical examination not less than once in three months, by competent medical men, of every employee in the establishment, to determine his physical condition and his fitness for his special work" (p. 150).

The subject of light and illumination in factories receives careful treatment: "In Holland the law requires a minimum intensity of 10 bougie-meters (1 foot-candle) to be maintained, and in some special industries, such as sewing, embroidery, knitting, printing, etc., an intensity of 15 bougie-meters (1½ foot-candles) is required" (p. 240).

Employers welfare work is considered, and incidentally "scientific management" is brought under review: "The chief opposition to scientific management in factories comes from the workers themselves, from their representatives, and from those social workers who dispassionately judge this new efficiency movement in industrial production" (p. 303). The example of an English manufacturing firm in employing a dentist to attend to the teeth of their workers is recommended for imitation.

The chapter on "Air Ventilation in Factories" includes forty-five pages and twenty-one illustrations; that on "Industrial Tests and Dusty Trades," an equal number of pages and thirty-seven illustrations. The illustrations in the chapter on "Industrial Poisons, Gases, and Fumes," by showing the intense discomfort of the necessary preventive measures, enable the reader to realise to a small extent the terrible dangers to which the workers in certain industries are exposed.

CACAO AND COCO-NUTS.

(1) *Cocoa.* By Dr. C. J. J. van Hall. Pp. xvi + 515. (London: Macmillan and Co., Ltd., 1914.) Price 14*s.* net.

(2) *The Coco-Nut.* By Prof. E. B. Copeland. Pp. xiv + 212. (London: Macmillan and Co., Ltd., 1914.) Price 10*s.* net.

THESE two volumes form notable additions to the literature of economic botany, and will be welcomed alike by planters and departmental officials. (1) For some years past the cacao planter has been tolerably well provided with useful handbooks, and an extensive and important literature has arisen in regard to special aspects of his industry. Dr. van Hall's task, therefore, has been undertaken with considerable initial advantage, but with a special opportunity of sifting the evidence now available and affording an authoritative summing-up. Few are better qualified for this task than the author, and the present volume unquestionably affords the best available discussion of the principles underlying the successful cultivation of cacao. The arrangement of the book follows established lines. Chapters on the history, chemistry, and botany of *Theobroma Cacao* are succeeded by a discussion of methods of cultivation, fermentation, and preparation for the market, and treatment of pests and diseases; there is, moreover, an admirable account of the varying methods of cultivation and preparation adopted under the varying conditions of the great cacao-growing countries. Throughout the book the usual English rendering, "cocoa," is adopted in preference to "cacao."

Among the most valuable chapters are those dealing with the botanical characteristics of the tree and its cultivation as a crop. The correct understanding of the morphology and physiology of the plant is of the greatest practical importance, and much of the author's convincing treatment of the problems of cacao cultivation rests upon his appreciation of this fact. Planters will turn with interest to the discussion of the perennial questions of "shade" and manures, while the account of the progress made in Java with experimental grafting and budding of selected varieties will be welcomed by West Indians, who were the first to recognise the possibilities of this practice. It would seem, however, that at present Dr. van Hall does not fully share the optimism expressed in certain circles in regard to the *practical* possibilities of this line of work. The author will gain the confidence of planters and others by his respect for the experience of sound, practical men and avoidance of dogmatic assertion: "It is a golden rule that cultural methods must always be entirely dependent on local conditions." The book is well printed and the numerous illustrations are excellent.

(2) Prof. Copeland's well-illustrated book is one of the best accounts of the science and practice of coco-nut culture that has yet appeared. As professor of plant physiology in the College of Agriculture of the University of the Philippines, the author has for some years past been occupied with researches into the physiology of the coconut palm, and the present volume is substantially a discussion of the practical aspects of coco-nut growing in the light of the results of his investigations. As main topics the author deals with the physiology of the palm, climate and soil, diseases, selection of seed, field culture, and coco-nut products. His own practical experience has been the basis for his treatment of planting practice, and, in consequence, the book is chiefly concerned with coco-nut planting as carried out in the Philippines. Special value attaches to the chapters on climate, soil, and culture, since, as might be expected, they have been written with full regard to the physiology of the plant, a subject dealt with all too briefly in an excellent and

suggestive section. The importance of selection of seed to meet the varying needs of the different markets for coco-nut products is insisted on in a very interesting chapter.

A pleasing omission from the book is the oft-encountered estimate of "cost of establishing a plantation," and the author explains the absence of statistics of coco-nut production on the grounds of their untrustworthiness. On the other hand, it should have been found possible to include, in the brief chapter on "Coco-nut Products," a reference to the now important trade in "desiccated coco-nut." It is interesting to note that the author follows Cook in regarding the American tropics as the home of the coco-nut palm; that he finds no evidence that salt is necessary for the full development of the plant; and that he discounts the view that sea-shores are the only proper localities for a plantation. S. E. CHANDLER.

MAN AND THE UNIVERSE.

(1) *The Concept of Sin.* By Dr. F. R. Tennant. Pp. iv+281. (Cambridge University Press, 1912.) Price 4*s.* 6*d.* net.

(2) *God and the Universe: a Physical Basis for Religion and Ethics.* By Prof. G. W. de Tunzelmann. Pp. 256. (London: S.P.C.K., 1912.) Price 4*s.*

(3) *The Principia or the First Principles of Natural Things, to which are added the Minor Principia and Summary to the Principia.* By Emanuel Swedenborg. Translated from the Latin by J. R. Rendell and I. Tansley, with an introduction by Isaiah Tansley, and a foreword by Sir William F. Barrett. Vol. i., pp. cv+545; vol. ii., pp. xxi+699. (London: The Swedenborg Society, 1912.)

(4) *Outlines of the History of Psychology.* By Prof. Max Dessoir. Authorised translation by Donald Fisher. Pp. xxix+278. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1912.) Price 7*s.* net.

(1) IN Dr. Tennant's lucid and fair-minded discussion of the meaning of sin particular points might indeed be criticised. But the query in one's mind is rather the general one as to the value of the concept—why has there been a "decay of the sense of sin"? This is dealt with in an appendix, but quite other reasons than those there recognised must, one feels, be faced.

There are two views of the world; as a slough to be crossed or a marsh to be drained. On the first indeed we shall assign ethical value to results "only in so far as these are exponents of the goodness of the will whence they spring." On the second, such things as suffering and ignorance are evil, not merely as "exponents," or in a "quasi-æsthetic" sense (indeed a Kipling may find a pleasing symmetry in the "widow in sleepy Chester" compensated by an expiatory heap of skulls in Cathay). The present war may be due rather to a collective fallacy than to sin; if its miseries would in that case have no interest for ethics—well, so much the worse for ethics. Just as the deadliest false witness is borne in good faith, so man's cruellest inhumanity to man has been done with approving conscience. Conversely Huck Finn, one supposes, sinned in aiding the runaway Jim, as did the Precentor in failing to enlighten the Little Minister's mother.

From this point of view, again, we shall ask first and last, What is feasible, what is modifiable? Now a man's standard of right is indefinitely alterable, but the degree of his conformity to it, his native conscientiousness, may, like his native retentiveness or intelligence, be fixed. So with the race; the standard changes while the deviation of individuals—the moral scatter—remains fairly constant. And in moulding the race of the future we cannot (apart from eugenics) assume the possibility of influence more direct than through the social environment. Further, the goodwill cannot be only formal if we are to avoid the circularities of the will to believe. And just as the "paradox of hedonism" has a psychological as well as a logical meaning, so the constant query "How shall I acquire merit?" though it need not produce the Pharisee, is yet far from that objectivity which is the mark perhaps of genius and surely of the idealist and love. To the mother the child is not an "exponent" of the parental instinct, but an end. Finally, even if life *is* an examination we are only candidates. To divide the sheep from the goats may be God's business; that it cannot be ours is indeed emphasised by Dr. Tennant. He warns us, too, that he writes for theological students rather than social reformers. But that is just it; we are all social reformers.

(2) Dr. Tunzelmann attempts to provide a "physical" demonstration of the existence of God. The mechanical view, or "model," of the universe has had to be supplemented by the energy model, and this, in its turn, fails to explain the initial distribution of energy that it presupposes. There remains only the mind model. That mind does affect the distribution of energy is "proved" by practically assuming interactionism. But even interactionism only refers to the relation of mind and brain, so that the argument would seem at best to suggest that the material universe is, or was, the cortex of Universal Mind. And mind does not will or know its own nervous correlates. Dr. Tunzelmann's argumentation is strangely un-

equal; often strikingly acute it is often as notably weak, *e.g.*, his identification of life and mind. Convincing as a refutation of crude materialism, the book is scarcely so in its more ambitious aims.

(3) Swedenborg's "Principia" suggests again the distinction between the examiner and discoverer points of view. As a candidate Swedenborg would deserve high marks; "nothing can dim the glory of this magnificent dash into the unknown," and it is easy to recognise in him anticipations of modern physical theories. But, alas! we want views which will not merely be consistent with future results, but will bring these nearer. There remains, no doubt, the purely historical interest, but the history of ideas is peculiar inasmuch as what was helpful in the past is preserved in the present, while the errors, though inevitable at the time, were not merely unsatisfactory as "models," but as mental habits had to be painfully unlearnt. Hence to the student of a science its history is apt to be confusing rather than helpful; and this difficulty one cannot but feel in the case of (4) Prof. Dessoir's history, even though the history of psychology is itself psychology, and excellently as the task is done. The translation reads well, but surely "moment" in the sense of "factor" is still somewhat German English?

C. S.

OUR BOOKSHELF.

Artificial Waterways of the World. By A. B. Hepburn. Pp. xi+171. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 5*s*. 6*d*. net.

THIS book, dealing principally with American waterways, also contains a short account of the principal canals of the world, and is well worth the attention of those interested in internal navigation.

The object of the author is stated to be to place before the public the salient facts as to internal artificial navigation in relation to commercial development. The author considers that the use of canals is to supplement and complement, and not to attempt to rival railways.

Canals have not now the same importance in the transport of materials and the development of the resources of England that they have in America, with its enormous area of inland country situated a long distance from the sea-coast. In Great Britain there are no fewer than eight first-class ports situated within comparatively short distances from the interior, and there is no large manufacturing town more than eighty miles from the sea-coast.

An interesting account is given of the original construction and subsequent improvements of the Erie Canal, the principal artificial waterway in the United States. This canal connects the country around Lake Erie with the seaport at New York. It was opened for traffic in 1825, and has, from time to time, been enlarged and improved, and is now capable of taking barges 150 ft. long and carrying 240 tons. It is State owned and now toll free. For a quarter of a century it was the greatest transportation line in the country, giving settlers in the west country an outlet for their products. With its connections it is 433 miles in length, and second only to the Great Canal of China among the artificial waterways of the world. Its importance has, however, been considerably diminished, the tonnage carried by this canal being now only about one-twentieth of that carried by the railways.

The British Journal Photographic Almanac, 1915. Edited by G. E. Brown. Pp. 1068. (London: Henry Greenwood and Co., Ltd.) Paper, 1*s*. net; cloth, 2*s*. net.

THIS volume is the fifty-fourth issue of the photographer's most useful companion, and will be found to be up to the usual standard of accuracy and completeness.

Two notable articles of great interest to amateur workers are those of "Modern Methods of Enlarging," by the editor, and "Photography with the Microscope," by Dr. Duncan J. Reid. Both of these deal with the subjects in clear and precise style, and are well illustrated by carefully selected diagrams. The *résumé* of the year's practical work and the section on novelties in apparatus bring the reader right up to date as regards methods and apparatus. The volume embodies as usual the many formulæ and tables needed in the practical man's work and such useful information as particulars of the photographic societies in the British Empire, etc. By no means unimportant is the well-arranged mass of advertisements of the numerous photographic firms in which the announcements of apparatus and materials are of great interest to the practical worker. Complete indices to text and goods advertised make the mass of valuable information included in these 1068 pages readily available.

Heaton's Annual. The Commercial Handbook of Canada and Boards of Trade Register, 1915. Edited by E. Heaton and J. B. Robinson. Pp. 516. (Toronto: Heaton's Agency; London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 5*s*.

THE eleventh annual issue of this useful work of reference will be welcomed by all who have commercial or other dealings with Canada. The detailed information is brought together in a form which makes it easily available, and it will prove of assistance to teachers of commercial geography as well as business men. This year, for the first time, an economic bibliography of the Dominion and Provincial Government reports has been added. The general information includes valuable notes on agriculture, technical education, fisheries, mining, and temperature and rainfall among other matters likely to appeal to students of science.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Measurements of Medieval English Femora.

As it was I who suggested to Dr. Lee the illustration of her mathematical work by a consideration of Dr. Parsons's recent paper on the English thigh bone in the *Journal of Anatomy*, and as I am further responsible for emphasising the extraordinary proportion of the sexes reached by him (owing, as I believe, to his fallacious method of sexing), I may, perhaps, be permitted to reply to his letter in NATURE of February 11.

In the first place, I should like to make a general defence of the action of the Biometric School in venturing to deal with what are too often supposed to be purely anatomical matters; I cannot forget that my criticism of another distinguished anatomist some years ago met with the reply, published in your columns, that he had no intention of discussing the matter with one whom he stated had no anatomical training. In a letter to Dr. Lee, Dr. Parsons emphasises the distinction between the man with anatomical knowledge and the person who approaches these problems with scientific training, but is wanting, so he assumes, in observational experience. Nearly twenty-five years ago, when I first entered from the mathematico-statistical side upon the study of craniometry and osteometry, I venture to think that there existed a very general Continental opinion that British work on these subjects was largely the product of dilettanti. The object of the Biometric School was to reverse that judgment, and to show foreigners, that we in England could provide not only measurements, but methods and results, which they would be compelled in self-defence to adopt, extend, and imitate. In the course of that quarter-century many thousands of crania, many hundreds of skeletons have passed through or remained in my Biometric Laboratory. We have had the most generous help of quite a number of highly trained anatomists, and have been compelled to study many anatomical memoirs. Is it likely that we should remain totally ignorant of the physical properties of the material we have had to deal with, or with the views of anatomists with regard to it? Indeed, one of our extreme difficulties has been the "pie-crust" character of many of the bones coming into our hands. Experience, however, has convinced me that sex has very little indeed to do with the destruction of either craniological or osteological material. That depends to some extent on age at death, but chiefly on the *immediate* physical environment during the period before exhumation of the individual skeletons. We are quite familiar with the distressing experience involved in boxloads of bone dust and bone fragments. But in the face of that experience I state that Dr. Parsons's sexing of the Rothwell femora which gives 64 per cent. males and 36 per cent. females is in error, and bears internal evidence of this error.

In the case of the Naqada skeletons which were among the first brought to my laboratory the wastage through the breaking up of material was excessive, the quantity of bone dust and fragments practically equalled the usable material; the centuries of desert exposure, and the long rough sea journey had produced a selection of bones some 6000 years old, which, if Dr. Parsons's views were correct, should have largely influenced the sex proportions. Yet on a sexing based on far surer ground than Dr. Parsons's, namely, on that of the crania and pelvic bones of the skeletons, we found 59 per cent. of the bones were *female* and only 41 per cent. of the bones *male*. Two series of long bones from London plague pits sexed *anatomically* gave only 56 per cent. males and 44 per cent. females, and the selective destruction in this material must have been very great. In this case the mathematical sexing, using the bicondylar width—which I shall show in a forthcoming memoir to be a more trustworthy sexual character than the femoral head—gave only 52 per cent. males and 48 per cent. females. Where we find—as we do find occasionally —a great disproportion in the sexes, and it is not due to archæological causes, *i.e.* battlefield interments, chief or warrior burials, monastic settlements, etc., it results, I believe, from the personal equation involved in much anatomical sexing. I have watched many an anatomist sexing; he may look at numerous points, but he has rarely given them relative *quantitative* weights; he is almost certain to be biassed by his pet sexual character in the living, the shape of the forehead, the bridge of the nose, the nape of the neck; from nasion to basion there is not a single feature of the skull which is not a pet sex-determinant to one man or another. And it is just the same in the far more difficult matter of long-bone sexing. It is the obliquity of the femur with one man, the muscularity with a second, the pilastric diameter with a third, while Dr. Parsons, following Dwight, pins his faith to the femoral head, and having reached results which give an immense male preponderance, explains it by re-stating the old axiom[1] that female bones cannot stand the wear and tear which male bones may be expected, owing to their stronger constitution, to survive. What if the female bones were by their smaller size likely to be subjected to a lower bending moment relative to their flexural rigidity? But Dr. Parsons's own material answers himself. His missing female bones are not the small but the *large* female bones, precisely those bones which were likely to be treated as male bones on his plan. If anyone with experience of frequency distributions will examine his distribution (on p. 256, *Journal of Anatomy and Physiology*, vol. xlviii.) they will find, not that the females are abruptly cut off on the *dwarf* side, but that females are abruptly cut off on the *giant* side, and males on the *dwarf* side. Why? Because in transferring Dwight's rule based on the mixed material of American dissecting rooms to an English medieval population, he has not only overlooked the complete difference of race and time, but a still more important point. *Dwight was measuring moist bones with the cartilage attached*—and, if Dr. Parsons meant to apply this rule, he should have subtracted 3 to 4 mm. from Dwight's limiting values before applying them to his own material!

Looking at Dr. Parsons's results on p. 256 I can but conclude that his sexing is based on a fallacy, and the dip he has created in the Rothwell femora between those with 45 and 47 mm. heads—the range of Dwight's supposed doubtful sex—is due to conscious or unconscious selection of his material; out of the great masses of bones available at Rothwell (which should have occupied in measurement of many characters and in their adequate reduction the whole time of a man for four or five years) Dr. Parsons has chosen a small series giving a remarkable dip at Dwight's limits, limits which I venture to suggest have here no application. These and other points will be discussed in our memoir on the London femora now at press. I write at present at this length merely to indicate that in suggesting to Dr. Lee to illustrate her tables on Dr. Parsons's material, I had in view many observational points which Dr. Parsons, like not a few of our English critics, considers we have made no attempt to appreciate—being "mere mathematicians." KARL PEARSON.

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[1] I should like as a layman to enter a vigorous protest against Dr. Parsons's, an anatomist's, opinion, that female bones disintegrate "for the same reason" as those of children!

Galton Laboratory, University of London.

A Remarkable Dry Fog in the East Indian Archipelago.

THE observations made on Ben Nevis upon the transparency of the air have shown very clearly that with increasing relative humidity the transparency is diminishing, a consequence of the increasing volume of the light-scattering particles, from which it may be concluded that the particles are of hygroscopic character.

The influence of humidity on the size of these particles was obvious in a very striking way in the dense dry fog that towards the end of the dry monsoon of 1914 spread out over the East Indian archipelago, causing much trouble to navigation.

A short description of this phenomenon is given below. The fog had a grey colour, and was most intense in the month of September, and especially in October, and disappeared when the rains fell. In its most typical form it appeared in Sumatra, in the neighbourhood of Ambon and the islands to the south-east.

In Sumatra it was observed to the north as far as Medan (Deli), the Karo plateau near the Toba lake and Tapanoeli, to the south as far as Benkoelen and the highlands of Kerintji. It was not observed in the open ocean outside the Mentawei Islands.

In the morning the sun was not visible before eight o'clock, when it appeared as a dim red disc. Objects in general were barely visible at 500 metres' distance, and on the thickest days invisible within half this distance; the mountains had disappeared entirely from view.

In Ambon the sea was sometimes invisible from the lighthouse, which is situated close to the shore, and 140 metres above the sea. Also in the straits between Sumatra and Borneo, and the west and east coast of Borneo, the fog was very thick, and though in somewhat less degree it was also observed in the northern part of the Strait of Makasser, on the north coast of New Guinea (in these regions, however, it was more or less mixed up with smoke from forest fires, which caused local intensification), on Sumatra's west coast north of Padang and Malakka Strait.

Though in the other parts of the archipelago the transparency of the air was greater, it was not quite clear, on account of the blue haze that is common to the dry season.

A similar phenomenon (described by Dr. van Bemmelen, *Meteorl. Zeitschr.*, August, 1905), perhaps still more intense, was observed in the very dry year 1902; it then extended to the southern part of the China Sea and to the south-east so far as the Tanimber Islands, the region of greatest intensity being about the same as in 1914. It was also reported from the abnormally dry years 1885, 1888, 1891, and 1896. In Karimata Strait it is a common phenomenon.

Now it is very remarkable that the southern boundary of the fog coincides rather closely with a well-defined line, that separates the region of practically no rainfall from that of greater humidity where light rains begin to appear. In 1914 this line ran in the months of September and October over the south-east point of Sumatra, along Billiton and Borneo's south coast, through Makassar Strait, along North Celebes, and south-eastwards along the south coast of New Guinea, Ambon, and the region south-east of it lying as an oasis of light rainfall in the dry region.

From this it is evident that it is the hygroscopic particles that form the blue haze in the south-eastern part of the archipelago, which, entering into moister regions and increasing their radius, give rise to the appearance of the grey fog.

Physical laws fully account for the fact that the fog is a mere intensification of the haze, though the rather fast transition of the light blue haze to the much thicker grey fog gives the impression of a new phenomenon springing into existence.

So long as the particles are much smaller than the wave-length, the intensity of the scattered light in relation to that of the light falling upon it, may be represented by $I=\alpha r^6/R^2\lambda^4$, when r is the radius of the particle, R the distance from the observer, and λ the wave-length. When r is increasing, the ordinary reflection ultimately appears, and $I=\beta r^2/R^2\lambda^0$.

From the method of dimensions may be concluded (conf. Rayleigh, "Theory of Sound," II., p. 152), I being a simple ratio and α and β passing gradually and rather slowly into each other as r increases, that as the exponent (n) of λ is changing from 4 to 0 the exponent (m) of r changes from 6 to 2. Therefore, so long as n is large enough to produce a colouring of the haze, m will cause a very rapid increase of the intensity of the scattered light, which may account for the rather sudden change of the blue haze to the grey fog.

It is not in the first place the greater number of particles that account for the difference between the transparency of the air in the dry and wet season, but their hygroscopic character. On December 23, 1914, when the wet season had already set in, I counted with Aitken's apparatus at Batavia 50,000 particles in 1 cub. cm., the relative humidity being 84 per cent., and no trace of haze was to be seen. However, on the Ardjoeno (at 2500 metres' height) on October 29, towards the end of the dry season, their number was only 1800 in 1 cub. cm., and notwithstanding the humidity was only 40 per cent., the surroundings were enveloped in an intense blue haze. Especially these very hygroscopic particles, when entering moister regions, will be susceptible to a strong increase of volume, and therefore will be the principal producers of the fog.

When we put the question where those highly hygroscopic particles come from that are responsible for the phenomenon described above, it may be remarked that for the greater part they do not form during the short journey of the trade wind over the archipelago. This takes only a few days, whereas the fog appears after many months of excessive drought. Two causes may be mentioned to which they owe their existence, viz., burning processes in Australia, which are also most frequent after long-prolonged droughts; and, secondly, which I take for the greater influence, the formation from the components of the air, ozone, nitrogen, etc., during the slow descending movement in the Australian anticyclone, in which the air probably takes several months to reach the layers near the surface of the earth. C. BRAAK.

Batavia, January, 1915.

A Penalty on Research.

IF Sir Wm. Ramsay was refused a rebate of the duty on alcohol I could scarcely expect better treatment. Nevertheless, I should like to add to his protest, and complaint After a correspondence lasting several weeks and some courtesy showed me by the local authorities I received the bluntest refusal to my request for a small supply of duty-free alcohol at my private laboratory in Cambridge, and this in spite of the fact that owing to an accident I am permanently prevented from leaving my house and availing myself of the duty-free alcohol at the biochemical laboratory of the University. H. ONSLOW.

11 St. James's Square, S.W., February 19.

MANY who, like myself, are privately engaged in biological research, will feel grateful to Sir William Ramsay for having directed attention to the difficulties which are unreasonably put in their way in regard to the supply of alcohol. May I take this opportunity of adding that, for those not connected with some university or museum, the only methylated spirit obtainable is adulterated to make it undrinkable, which also makes it absolutely useless for the operations of the biologist, who is thus driven to incur great expense in the purchase of alcohol. Some time ago I applied to the excise officers here for a licence to be supplied with methylated spirit for use in research work, and I offered to enter into any bond and to comply with any regulations they liked to impose to ensure its safe custody and honest use. After a correspondence extending over nearly three months, this licence was refused. I hope that Sir William Ramsay's letter may receive attention in the proper quarters, and that reasonable facilities may be given for the supply of both alcohol and methylated spirit for the purposes of research.

ARNOLD T. WATSON.

Sheffield, February 22.

Cement for Polarimeter Tubes.

I SHALL be much obliged if any reader of NATURE will suggest a cement suitable for fastening the end discs to polarimeter tubes. The cement I should like to hear of should be capable of withstanding the action of organic liquids at temperatures between 200°–300°. Fusion of the discs to the tubes would, of course, be best, but would be almost certain to introduce strain. There is no great difficulty in working without cement up to about 200°, but beyond the temperature at which rubber melts—and is, therefore, unsuitable for washers—the problem of keeping the liquid in its tube is by no means a simple one. Possibly someone engaged in work making similar demands may be able to assist me. T. S. PATTERSON.

University of Glasgow, February 20.

The Prices of Chemicals.

"J. J.'s" complaint against chemical dealers for unduly raising prices in consequence of the war seems to have been unjustifiable in the case he mentioned, but it would apply in some other cases. A few weeks ago I wrote to several dealers for some racemic acid; one firm, who had a stock of only half an ounce, let me have it at the pre-war price, whilst another, with a larger stock, charged me just double. S. P.

THE MANUFACTURE OF DYESTUFFS.

THE GOVERNMENT'S MODIFIED SCHEME.

THE discussion on the various aspects of the problem of producing in this country an adequate supply of dyestuffs proceeds without intermission. The question has for some time assumed a national aspect and has been the subject of Parliamentary debate or question on at least three occasions. It has also been debated at meetings of the Chambers of Commerce in the chief industrial centres, and people most directly interested have had many opportunities of expressing their opinions at meetings of their various organisations, or at gatherings specially convened for the purpose.

To a great extent the discussions have centred round the adequacy and equity of the commercial proposals involved in the official scheme now before the public. These have received much more general acceptance than those put forward in the first scheme, and it appears probable that the committee has now received promises of support to an amount representing a substantial proportion of the initial capital proposed for the new company.

The members of the committee themselves admit that it is an easy matter to criticise the scheme adversely, and it is obviously impossible to devise a solution of the problem satisfactory to all minds.

If the matter is to be viewed as an ordinary commercial proposition, if questions of free trade or protection are to be taken into account, or if early dividends are to be assured, then any scheme which might be put forward could be shown to be unworthy of support. But whilst criticism on these lines has been plentiful, there has latterly been a rally of support by those taking broader views—a support which has probably been largely induced by a sense of national need, and has certainly been greatly developed by the action of the Government in offering to endow the research work which is essential to the extent of 100,000*l*. This action has engendered a feeling of confidence that the Government will take any further steps which the future may show to be vital to the success of the British dye manufacturing industry.

It is to be hoped that the committee in charge of the scheme will shortly be able to announce the results of its inquiries and that these will show that the great textile trade of the country has responded adequately. In the meantime, the arrangements for carrying out the necessary preliminary chemical work should be proceeded with.

A Mobilisation of Chemists.

Speaking in Bradford on February 8, the present writer advocated immediate action by the Government or the Board of Trade Advisory Committee in the direction of utilising the services of British chemists. There is on one hand a large amount of chemical work to be done before the industry can be greatly developed, and on the other, there is a great number of well-staffed and well-equipped laboratories in our universities and technical colleges which might render great service to the industry. To avoid wasteful duplication of work and to co-ordinate the results, it is essential that some organised scheme and allotment of work should be arranged, and it is suggested that a conference of those concerned should be held at an early date to formulate such a scheme. Even if to-morrow the whole of the available chemical force set to work on some organised plan, it would not be any too soon to get the necessary information together for the use of the existing works and the new works when they are started.

The urgency of this action is further shown by a resolution passed by an important meeting held in Manchester on February 16, which was presided over by Sir Chas. Macara. The resolution, which was carried unanimously, stated: "That in the opinion of this meeting the Government would do well to organise immediately the present chemical talent in the country with a view to chemical research being undertaken for, and on behalf of, all manufacturers interested, and that the services of these experts should be available for all desirous of availing themselves thereof."

The adoption of such a plan for bringing the educational institutions more closely into touch with the industries would in all probability mark the beginning of a new era in which both would benefit. The more intimate association of professors of chemistry with chemical industry would introduce into the works that higher ideal and broader scientific spirit upon which successful research and development depend, whilst the schools would benefit by the great incentive of practical reality.

The Parliamentary Debate.

Since the above was written, the important debate in the House of Commons on Monday, February 22, has advanced the matter another stage. The criticisms offered by various speakers raised few novel points, and the general tone of the debate was, on the whole, favourable to the Government scheme. Several speakers, including Sir Philip Magnus, expressed the opinion that the grant of 100,000*l.* for research work was totally inadequate. Mr. A. Chamberlain and others emphasised the great difficulties the undertaking would have to face on the conclusion of the war, and many speakers acknowledged that the question of the manufacture of dyes was of such a special character as to warrant quite exceptional treatment.

Mr. Runciman, speaking on behalf of the Government, made the interesting announcement that upwards of 400,000*l.* has already been subscribed towards the capital of the new company, and further stated that the signing of the five years' agreement was not an essential condition of subscribing capital, but that priority of supply would be given to those who had given the undertaking. His concluding remarks may be quoted: "I am surprised that anyone should suggest that we have not adequate chemical knowledge in this country. We have sufficient first-class men, but we lack an adequate number of second-class chemists, which we shall not produce if they are only paid 3*l.* a week.

"Even if this were only an emergency scheme the million pounds promised by the Government would be well spent. A single month of unemployment in the textile trade would mop up more than that of our national money. It is the disadvantage of all practical schemes that they are full of compromises, but no step has been taken without a practical reason."

WALTER M. GARDNER.

ON COLOUR SENSITISED PLATES.[1]

II.—THEIR APPLICATIONS. PANCHROMATIC PLATES. TESTING DYES, ETC.

The commercial "ortho-" or "iso-chromatic" plates, which are specially sensitised for green, besides their obvious uses for scientific purposes in which red sensitiveness is not necessary, are of especial use in the photography of coloured objects where an improved result, as compared with an ordinary plate, is desired, rather than a full correction. As the unassisted eye is not a very keen critic of the relative brightnesses of different colours, especially when they are not in juxtaposition, such an improvement is often all that is necessary. The deficient sensitiveness to red causes a pure red to be represented as if it were black. But almost all colours in nature and most artificial colours are not pure, and so far as a red contained any green or white, that is so far as it reflected any other light whatever in addition to the pure red, except pure blue, then the rendering of the red would be improved. But this fact as to most natural colours being mixed is also a disadvantage, for all coloured objects, so far as they reflect any red, will suffer because of the want of red sensitiveness of these plates.

Plates are made specially sensitised to red and called red and yellow sensitive, and practically all that has been said with regard to green sensitised plates, both now and in the previous article, applies to these, only that the deficiency here is green instead of red.

By the use of more than one sensitiser, plates may be sensitised to both green and red, and the early panchromatic plates were of this type. They had three maxima of sensitiveness, one in the blue due to the plate (that is, the silver bromide) not specially sensitised, and one in the green and one in the red due to the two sensitisers. Such plates may be regarded as being as much of an improvement on "orthochromatic" plates as these are on ordinary plates, but the sensitiveness is uneven, and they consequently suffer as already described. By the careful selection and combination of sensitisers this unevenness has been very largely overcome in the panchromatic plates of the present day. Excessive blue sensitiveness of course remains, but this is easily obviated by a pure yellow filter.

The three illustrations (Fig. 2, *a*, *b*, *c*) show the effects of various colours by the use of ordinary, orthochromatic, and panchromatic plates, respectively. The colour filter used with the orthochromatic plate might with advantage have been rather darker. The "L" near the middle is deep blue, the word "mark" is white, and the ground they are on is yellow. The book covers are red. It will be noticed how the panchromatic plate gives the yellows better than the orthochromatic plate, and gives the reds, which the orthochromatic plate renders in the "Gazetteer" and "Atlas" as if the red paper was of the same colour as the black printing ink. Other effects will be clear without further description.

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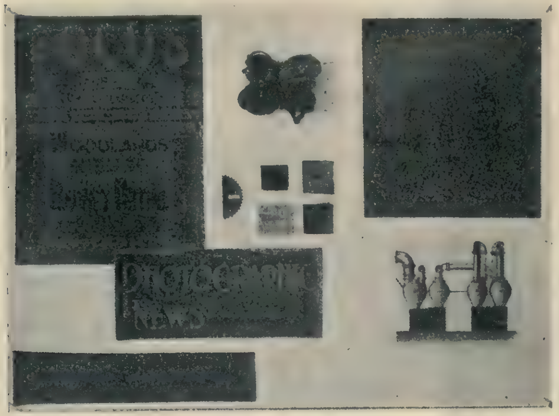
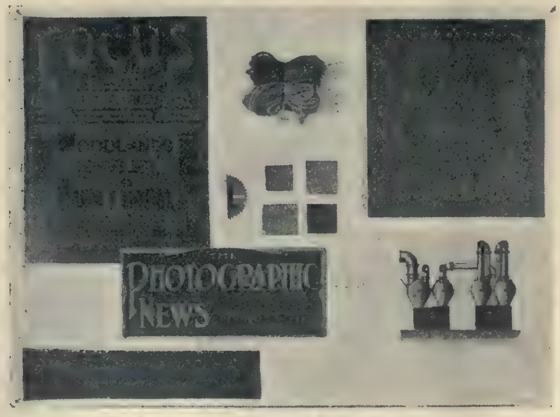
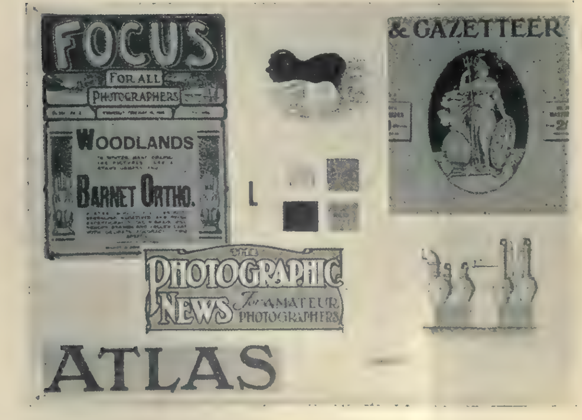
[1] Continued from p. 677.



(*a*) Ordinary Plate.



(*b*) Isochromatic Plate and Yellow (×4) screen.



(*c*) Panchromatic Plate and Yellow (K 3) Screen.
FIG. 2.

Panchromatic plates have been made commercially for fifteen years or more, but the plates of the last few years are very superior to their predecessors. Some makers issue more than one kind, the variation so far as colour sensitiveness is concerned being chiefly as to the extent of the red sensitiveness. Some are sensitive only to about the red lithium line or the C line in the solar spectrum. Others are sensitive to beyond the A line or the red potassium lines, and plates can be supplied that are sensitive considerably further into the infra-red. For the correct representation of coloured objects infra-red, and even the extreme red, sensitiveness is only harmful, just as ultra-violet sensitiveness is, because these radiations are dark to the eye. It is well to choose a plate for this purpose that is not sensitised to the extreme red, and it is necessary to use a colour filter that cuts off the ultra-violet (some of the older yellow filters did not do this) and reduces the intensity of the blue so that it does not produce an undue effect. With a modern panchromatic plate a suitable filter will require the exposure to be increased perhaps only five times, as compared with the exposure necessary for a white object without the filter. This does not mean that such a plate and filter will give a sensitiveness curve that will exactly coincide with the luminosity curve of the solar spectrum, but it is a very near approach to it, so near that for general purposes it is more important to see that the present degree of perfection is maintained, rather than that it is increased, though of course we hope for still better results in due time.

There are many uses to which colour sensitised plates and colour filters may be put besides the correct representation of colour luminosities in the photography of objects, spectrum photography, and in connection with three-colour reproduction processes. Given black and white and any single colour, it is possible to photograph the three so that the colour is represented as if it were *either* black or white. Take the simple case of a drawing or manuscript in black ink on white paper with alterations in red ink. The red alterations can be made to appear as black as the black ink by using blue (or blue and green) light only, that is, a light which has no red in it. An ordinary plate, which is sensitive only to blue, will give this result. But the red alterations can be made to appear as white, and therefore to disappear, by using red light only, that is, a plate sensitised to red in conjunction with a red colour filter. Engineers' drawings in blue, as when copied by the ferroprussiate process, give poor contrast on ordinary plates because the active light is chiefly blue, but with a red sensitised plate and red (or yellow) filter the blue becomes practically black. Similarly it is often possible in photography to eliminate stains on documents, or to find an inscription that has faded into invisibility. In this latter case it may be well to use extreme measures, as including as much ultra-violet as possible in one experiment, and the extreme red in another, if the colour character of the detail being searched for is unknown.

By modifying such extreme measures as just described, it is obviously possible by photography to intensify or diminish the apparent effect of any colour, and so, as for example in stained physiological sections, to improve on the original, or from one original to get two (or more) photographs that represent the section in, as it were, two (or more) different conditions as to staining.

The photographer has also by such means a very large measure of control over the effect of mist. The writer has shown that light is scattered by particles of a diameter equal to half a wave-length of the scattered light. By passing a brilliant pencil of light through a flask of filtered distilled water the path of the pencil may be scarcely visible (the "Tyndall effect"). But by photographing the arrangement on an ordinary plate, that is, using blue and ultra-violet light, the path of the light will probably be shown very conspicuously indeed, the particles that escaped removal by filtration being not large enough to scatter light of greater wave-length than the ultra-violet and the extreme blue. When the particles of the mist or turbidity are graduated in size, as they generally are, and are not coarse like the dust that may be stirred up from a dry road, then the longer the wave-length of the light used the less does the mistiness show in the photograph. When the air is misty, by the use of a yellow filter distant objects may be photographed more clearly than they can be seen, and by using only infra-red light Prof. Wood has obtained photographs in which the sun shines, though there was only a grey cloudiness visible.

Though the colour sensitising of plates is now as much the manufacturer's business as the preparation of emulsions and the coating of the plates therewith, the experimentalist may wish to try the effect of a dye for himself. The solution must be very weak indeed, say one of the dye to from 10,000 to 50,000 times its weight of water. Ammonia is often advantageous to the extent of one per cent. of the whole. The best formula is simply a matter of experiment. The following, for example, is a varation recently published by Messrs. Michaud and Tristan (*Brit. Jnl. of Phot.*, lxii., 56) for sensitising for the red and infra-red:—

Alcohol 50 per cent., 200 c.c.
Ammonia, 4 c.c.
Alizarin blue S, 0·04 gram.
Silver nitrate 10 per cent. solution, 5 drops.

The same dye is efficient without the silver salt and the alcohol, but presumably these are advantageous. In general, after the plate has been in the dye solution for two or three minutes, it is washed for a few minutes and then dried. Plates so treated vary very much as to the time that they will remain in good condition. For example, plates bathed in the solution quoted above must be used within a few hours, but in other cases they may last for months.

It is much less risky to make colour filters than to bathe plates, as most dye solutions will be absorbed by a clean gelatine film. But colour filters are now made by several firms, and the Wratten department of Kodak catalogues standardised colour filters of nearly a hundred different transmissions.

CHAPMAN JONES.

PROF. G. F. J. ARTHUR AUWERS.

THE brief paragraph in our issue of last week, announcing the death of Prof. Auwers, must have been read with the deep regret that follows the loss of one who long occupied a commanding position in the world of science, and whose place it will be difficult to fill. For more than fifty years he had illuminated the science of astronomy, and by providing much of the material by which it is hoped to attack successfully the problem of the structure of the sidereal universe, he linked together the astronomical thoughts and methods of the past with the philosophical problems that engross and captivate the attention of astronomers of to-day.

In the history of astronomy of position, by which is understood the accumulation and arrangement of facts depending on a star's place in the sky, three names stand out prominently. Bradley, in whose valuable series of observations, long waiting for an interpreter, lay hidden the secret of stellar proper motion; Bessel, who made these measures available to the astronomers of his day; and Auwers, whose early appreciation of the necessity of the highest accuracy gave to these observations an increased value by his long and patient examination, laying the foundation of that system of thorough uniformity which has welded meridian observations into a more consistent whole, facilitating the combination of star catalogued places on a common basis, by the removal of systematic errors or discrepancies. Auwers taught the necessity for a higher standard of accuracy, and it is not too much to say that in the department of reduction and discussion of observations he long stood without a rival. His *forte* lay in the control and management of large masses of work, in the unhurried, careful supervision of every stage, bringing an acute and trained judgment to bear equally on all parts of the investigation.

If his reputation rests especially on his re-reduction of Bradley, it must be remembered that he encouraged and assisted other large undertakings. He took a prominent part in the re-observation of the Durchmusterung zones, a work of many years' international co-operation successfully carried out under the auspices of the Astronomische Gesellschaft. He was among the first to investigate the proper motion of faint stars, and he foreshadowed some of the conclusions that have been established by the most modern and thorough of inquiries. The determination of solar parallax by the method of the transit of Venus is a somewhat discredited problem now, but forty years ago it occupied a very conspicuous position, and Auwers's work on the German share in the complete investigation exhibits at least all that could be derived from the process. Of still earlier date, and of unquestioned excellence and success, were his discussions of the variable proper motion of Sirius and Procyon. How brilliantly his location of the position of the unsuspected satellites was justified, is well known.

It would be impossible to do justice in a short notice to talents so varied and to an industry so active as Auwers exhibited throughout a long career, but it may be permitted to say that, notwithstanding the bitter estrangement that separates us from German thought and German ambitions, every English astronomer would be willing to lay a tribute of respect on the grave of Arthur Auwers. W. E. P.

NOTES.

Sir Anthony A. Bowlby has been chosen Bradshaw lecturer of the Royal College of Surgeons of England for the ensuing year.

It is announced in *Science* that Prof. R. H. Richards, professor emeritus in the Massachusetts Institute of Technology, has been awarded the gold medal of the Mining and Metallurgical Society of America in recognition of his services in the advancement of the art of ore dressing.

At the meeting of the Royal Geographical Society on Monday, February 22, Dr. Page, the American Ambassador, presented to Dr. Scott Keltie, secretary of the Royal Geographical Society, the Cullum gold medal for long and eminent service to geography, awarded by the American Geographical Society.

The gold medal of the Institution of Mining and Metallurgy—the "blue ribbon" of the profession—has been awarded to a distinguished Canadian, Dr. Willet G. Miller, provincial geologist of Ontario, in recognition of the eminent services rendered to mining by his admirable work as an economic geologist.

The officers of the Royal Astronomical Society elected at the annual meeting on February 12 were as follows:—*President*, Prof. R. A. Sampson; *Vice-Presidents*, Dr. J. W. L. Glaisher, Major E. H. Hills, Dr. W. H. Maw, and Prof. H. H. Turner; *Treasurer*, Mr. E. B. Knobel; *Secretaries*, Prof. A. S. Eddington and Prof. A. Fowler; *Foreign Secretary*, Prof. Arthur Schuster.

Prince B. Galitzin has been elected an honorary fellow of the Physical Society. The following is the list of officers of the society elected for the ensuing year:—*President*, Sir J. J. Thomson. *Secretaries*, Dr. S. W. J. Smith (Royal College of Science, S.W.), and Dr. W. Eccles (University College, Gower Street, W.C.). *Foreign Secretary*, Dr. R. T. Glazebrook. *Treasurer*, W. Duddell. *Librarian*, Dr. S. W. J. Smith.

At the annual general meeting of the Geological Society, held on February 19, the following officers were elected:—*President*, Dr. A. Smith Woodward; *Vice-Presidents*, Dr. H H. Bemrose, Mr. Clement Reid, Dr. A. Strahan, and the Rev. H. H. Winwood; *Secretaries*, Dr. H. H. Thomas and Dr. H. Lapworth; *Foreign Secretary*, Sir Archibald Geikie, O.M., K.C.B.; *Treasurer*, Mr. B. McNeill. The president's address delivered at the meeting dealt with the evolution of the fishes in geological time.

The virtual German monopoly in the manufacture of dye-wares is a matter of national concern in other countries as well as in Britain. It is announced that arrangements have been made by the Benzol Products Company of Philadelphia to commence dye manufacturing on a large scale in about six months' time. A new company, styled the "Russian Society of Chemical Industry," has also been formed in Moscow to manufacture dyes for the sixty large consumers in that district.

On Tuesday next, March 2, Prof. W. J. Pope will begin a course of two lectures at the Royal Institution on colour photography (scientific applications): (1) "Photographic Appreciation of Colour in Monochrome"; (2) "Photography in Natural Colours"; and on Thursday, March 4, Sir Herbert Warren will begin a course of two lectures on poetry and war. The Friday evening discourse on March 5 will be delivered by Prof. E. B. Poulton on mimicry and butterflies, and on March 12 by Sir Rickman J. Godlee on back to Lister.

News has been received of the arrival at Khartum of Dr. C. Christy, who has been engaged during the past three years on a zoological mission in the Belgian Congo undertaken officially on behalf of the museum at Tervueren. We hear that he has made very large collections of the animals of the Ituri forest and other regions of the Congo traversed by him, though it is difficult to say what is to become of the specimens under the conditions existing in Brussels. Dr. Christy was fortunate in shooting two okapi, thus joining the very small band (not more than three or four) of white men who have shot an okapi. Nearly all the specimens now in Europe were killed by natives. Dr. Christy's bag also included several specimens of Meinertzhagen's great black forest pig and many of the dwarf Ituri buffalo.

Science announces the following deaths of men known in the scientific world:—Dr. Anthony Woodward, at one time assistant in the department of geology and for thirty-seven years librarian of the American Museum of Natural History, New York City; M. Alfred Tournier, formerly professor of viticulture at the University of California and later connected with the U.S. Department of Agriculture, who was killed on December 12 in the war; Dr. C. F. Brackett, professor emeritus of physics in Princeton University, in his eighty-second year; Dr. B. Sharp, formerly corresponding secretary of the Philadelphia Academy of Natural Sciences and professor of invertebrate zoology there and in the University of Pennsylvania, aged fifty-six years.

We regret to announce that among the victims of the war must be numbered M. Joseph Déchelette, the eminent French archæologist, who was killed in action on the Aisne on October 4 last, at the age of fifty-three. His most important work was the "Manuel d'archéologie préhistorique celtique et gallo-romaine," which, unhappily, after the issue of two volumes, remains unfinished. He also, in collaboration with M. E. Brassart, published "Les peintures murales du Moyen âge et de la Renaissance en Forez." He was also the author of works on "L'oppidum de Bibracte," "Les fouilles du mont Beuvray," and "Vases céramiques ornés de la Gaule Romaine," for which he was awarded the medal of the Académie des Inscriptions et Belles-Lettres, and was appointed Chevalier of the Legion d'honneur. The death of this indefatigable archæologist, who was Conservateur of the Musée de Roanne, is a serious loss to French archæology.

ALTHOUGH much of the activity of research laboratories has been curtailed by the war owing to the patriotic action of the younger workers joining one of the Services, there remain a number of men and women carrying on research. In the subject of chemistry special difficulties have arisen because practically all very pure chemicals have hitherto been made in Germany. No very large stock of chemicals of this description is held by dealers, but researches either completed or abandoned have left a considerable amount in public and private laboratories in this country. In an attempt to render these stocks available to workers, the chemical department of the Imperial College, South Kensington, has started a bureau of exchange. Circulars have been sent to most of the university and college laboratories in the kingdom asking for lists of chemicals which are not in immediate use. Many lists have already been sent, and workers who are in urgent need of fine chemicals have been put into communication with those who have some to dispose of. It is hoped that any chemist who has not received the circular will communicate with the bureau giving a list of the materials he has available and also his requirements. As a rule, chemicals have been sold at cost price, but the financial arrangements are left entirely to the buyer and seller.

THE Medical Committee of the British Science Guild has done a good work by its resolution condemning a notorious anti-vivisection advertisement. The object of the advertisement was to prevent our soldiers from being protected against typhoid fever. If it be asked why any one of the many anti-vivisection societies should behave in this way, we can only say with Dr. Watts that "Satan finds some mischief still for idle hands to do." Anti-vivisection since August has been more or less short of work. Few of us are wanting to hear Pasteur called a charlatan; few of us are wanting anti-vivisection lectures and shops. Everybody is sure, who is capable of clear thinking, that our men of science are neither cruel nor stupid. But anti-vivisection cannot rest. It must find something to attack, something to abuse. Happily, by mere vulgar abuse, it does itself more harm than good; and we may well believe that quiet, level-headed, charitable folk are mostly by this time sick of the very name of anti-vivisection. We hope that it will be many years before anti-vivisection emerges out of the public disgrace which it has brought upon itself. The resolution of the British Science Guild is fairly outspoken, though it might justly have used stronger language. We hope that it will be very widely circulated; half a million copies, distributed through the country, would be none too many

THE second Indian Science Congress was held, under the auspices of the Asiatic Society of Bengal, in Madras, from January 14 to 18 last. There was a large and representative attendance of delegates from all parts of India, and the Hon. Surg.-Gen. Bannerman, I.M.S., who is president, delivered an address. According to the *Pioneer Mail*, the president insisted on the importance of a knowledge of biology to medical, sanitary, and scientific men working in the tropics. In the course of an appeal to wealthy Indians to endow medical research so that their poor but capable fellow-countrymen might have something to look forward to as a reward for scientific toil, Surgeon-General Bannerman said:—"There are plenty of subjects for research which ought to be endowed, chairs in our medical schools and universities that ought to be established all over India. Indian universities are at present mere skeletons. Will no one here take up the rôle of beggar and try to extract a few lakhs of rupees from the hoards of his wealthy and aristocratic friends?" Continuing, he said India wants to have, not only more chairs and lectureships, but also research scholarships or fellowships, established fellowships, available for a student and research worker, so that he may live in reasonable comfort and be able to devote his whole energy to work, without anxiety for those depending on him. In Madras a beginning has been made in this direction, owing to the enlightened liberality of the Raja of Pithapuram, who has presented 50,000 rupees for the expenses of an inquiry into diabetes, the fell disease which has carried off so many of the best brain workers in this part of India.

THE authorities of the Sheffield Public Museums are to be congratulated on the attention they are devoting to the collection and classification of documents and other records relating to local history. The systematic collecting of such records, as we learn from the report for the period from March, 1912, to March, 1914, was commenced at the High Hazels Museum in 1901, and afterwards extended to the establishment in Weston Park. The gift to the Public Library of the "Jackson Collection," rich in documents relating to Sheffield, has largely added to the value and interest of the series, which is now very extensive.

"PIGMY" stone implements form the subject of an article, with two plates, by Mr. C. Hartley in *Spolia Zeylanica* for December last (vol. x., pt. 36). Such implements occur locally in many parts of the world, including the British Islands, but they are nowhere more common than in Ceylon, where they occur in great profusion at Bandarawela. At least ten distinct types of these implements are recognised by the author, but axe-heads, together with saws, spear-heads, and punches, are totally wanting. The question whether the pigmy and the ordinary Neolithic types of implements were manufactured and used simultaneously by a single race is, for the present, left without a definite answer.

In *Man* for January Mr. Edge Partington supplies a graceful obituary notice of Mr. Norman Hardy, one of the best of our anthropological artists, who died about a year ago. His work began with illustrations for Dr. Beddoes's "Races of Mankind." He travelled widely in Australia and the Pacific, and some of his best drawings appeared in "The Savage South Seas" and "Women of all Nations." In 1907 he went to the Kasai with the expedition led by Mr. E. Torday, and his last work was the tracing of the wall paintings in the tombs of the Kings at Thebes. He was for many years an active member of the Royal Anthropological Institute, where the simplicity and kindliness of his nature, as well as his skill as an artist, won him the regard of many friends.

In the proventriculus of the flea there is a valvular arrangement of chitinised spine-like epithelial cells which normally prevents the regurgitation of blood from the stomach during the act of sucking. A. W. Bacot and C. J. Martin have shown that in the plague-infected flea this mechanism is upset by a copious growth of plague bacilli which gets entangled among the spines, thus allowing the regurgitation of infected blood and the infection of a new host. In the fourth Plague Supplement of the *Journal of Hygiene* (January), this mode of transmission of plague by the flea is further elucidated by Bacot as the result of a study of serial longitudinal sections of infected fleas. Bacot also shows that in cool weather fleas are able to survive and to carry *B. pestis* for periods up to forty-seven days in the absence of any host, and afterwards to infect mice. He also shows that under experimental conditions bugs can transmit plague from mouse to mouse. Active healthy mice, however, eat the bugs, and an ingenious arrangement is described whereby the bugs are given shelter in saw cuts in the walls of wooden tubes in which the mice reside. Blood in the bug's stomach does not form so favourable a medium for the growth of the plague bacillus as in that of the flea, and it would therefore appear that the bug is not likely to be an active carrier of the infection under natural conditions.

The June number of *Peru To-day* contains an article entitled "The Conquest of Verruga," by Mr. C. H. T. Townsend, entomologist to the Peruvian Government. The author gives a brief summary of the results of his investigations upon Verruga Peruana, a disease which causes great ravages and much mortality in the Andes, and he claims to have solved the problem of the etiology of the disease and to have proved conclusively that it is transmitted by a tiny fly, a species of Phlebotomus, to which he has given the name *P. verrucarum*. The fly is crepuscular and nocturnal in its habits, remaining hidden by day in caves or in crevices in rocks and in the walls of human habitations. Protection against the fly, and consequently against the disease, can be obtained by sleeping under muslin-nets, by applying ointments to the exposed parts of the body just before dark, and by the use in bedrooms of electric fans arranged in such a way as to direct strong currents of air towards the open windows through which the flies come in. The flies appear to breed in the canyons in which there is sufficient moisture to support a luxurious vegetation, but not in the dry canyons without vegetation; the life-history of the fly has not yet, however, been observed. The author believes that small rock-lizards constitute a reservoir for the disease, and that the flies, which feed naturally on the blood of these reptiles, transmit the virus from them to human beings.

One of the most difficult problems with which the museum curator has to deal is to find a satisfactory method of presenting fishes for public exhibition. Stuffed specimens are an abomination; spirit specimens, however cunningly painted, are worse; and the ordinary type of cast is altogether wanting in sharpness and definition, owing to the external layer of plaster being disintegrated by the mucus from the skin during the process of setting. For the latter defect Messrs. Gill and Fletcher, of the Hancock Museum, Newcastle-on-Tyne, claim, in the February number of the *Museums Journal*, to have found an effectual remedy, and, judging from the figure of one ready for painting, their casts certainly seem to be a great improvement on the old-fashioned type. A continuation of the article is to follow.

"An Appreciation of Theodore Nicholas Gill," illustrated by a portrait in academical robes, is the title of an article communicated by Prof. A. Lucas to the January number of the *American Museum Journal*. Dr. Gill, who died in September last, is regarded by the author as having possessed an extraordinary grasp of various branches of zoology, and this despite a natural indolence, which led him to forgo personal investigation, and to rely largely on the work of others as a basis for his own generalisations. Among the latter "were the recognition of the claim of the elasmobranchs to a position of the 'highest' rank, and of the purely artificial nature of the groups Carinatæ and Ratitæ among birds." As regards the latter item, his views, which are undoubtedly correct, were diametrically opposite to those of the late Prof. Alfred Newton.

Mr. S. Taber discusses the earthquakes of the Charleston district in the Bulletin of the American Seismological Society of America (vol. iv., 1914, pp. 108–60). The earthquake-series of 1886 was preceded by a prolonged interval of repose, only eight shocks being recorded during the previous two centuries. Since August, 1886, the decline of the after-shocks in frequency has been gradual though fluctuating, 318 being reported from 1886 to 1897, and 77 from 1898 to 1913. The shocks are most frequent in September and rarest in April. Mr. Taber considers the relations between earthquake-frequency and various meteorological and astronomical factors. He finds that shocks are most frequent after long-continued periods of local rainfall, when the pressure of the underground water is relatively greatest on the north-west side of the originating fault, and when the barometric gradient is directed to the south-east. On the other hand, he can discern no relations between earthquake-frequency and changes in barometric pressure or the tides of the neighbouring coast or sunspot maxima or lunar periodicities.

DR. E. WARREN gives, in the Annals of the Natal Museum for September, 1914 (vol. iii., pt. 1), a full and well-illustrated description of a remarkable plumularian hydroid zoophyte discovered on living oysters in 1911 on the coast of Pondoland, of which a preliminary notice has already appeared. Although nearly allied to those species of Plumularia with hydrothecæ arising from the main stem, it differs by the presence of pinnules on some of the pinnæ, thereby approaching Schizotricha, in which nearly all the pinnæ are thus furnished. It is therefore provisionally included in that genus, as *S. simplex*. Its main claim to interest is, however, connected with its reproduction, which is of a unique type. Instead of the egg being furnished with a yolk-supply sufficient to maintain the young until capable of foraging for itself, as in the great majority of invertebrates, "the egg remains quite small and is never provided with a perceptible quantity of yolk, but segments, and development takes place, in a kind of maternal placental tissue which supplies the embryo with food during the whole development." In another article in the same issue Mr. H. C. Burnup reviews the minute pyramidal striated S. African land-snails of the genus Ennea, with descriptions of new species and races.

THE recently received number of the *Philippine Journal of Science* (vol. ix., sec. c., No. 4, August, 1914) contains two papers by Mr. E. D. Merrill, in which no fewer than ninety-three new species of Philippine plants are described. Forty-three were collected by Wenzel in the island of Leyte, whose collections have already added very largely to a more complete knowledge of the rich flora of the archipelago. The other new species come from various islands, and are included in Mr. Merrill's tenth and concluding instalment of new or noteworthy Philippine plants.

STEPS are being taken to secure the trade in senna in British hands. The plant from which the finest quality of senna is obtained grows in the Sudan, where the leaves and pods are collected and dried by natives, and sold to collecting agents for export. At one time this trade was entirely British, and the produce was sold through London, but afterwards it passed into German hands. The Imperial Institute has been in communication with the chief British importers and with the Egyptian Government, and the export of senna from Egypt has now been prohibited except to the United Kingdom and France. British firms are making arrangements direct with the native growers, which should not only restore the trade to this country, but lower the price and secure the purity of the supply.

MR. W. G. REED, of the Department of Geography of the University of California, presented a paper, "Climatic Provinces of the Western United States," to the Cordilleran Section of the Geological Society of America, and this paper has been printed in the Bulletin of the American Geographical Society (vol. xlvii., No. 1). After discussing various classifications, such as those of Supan and Herbertson, Mr. Reed advances a new classification based upon considerations of rainfall, temperature, and relief. The area from the coast to the Rockies is divided into four main regions, a northern and southern coast strip divided at 40° N., and a northern and southern "rain-shadow" strip divided about 43° N. The coast strips are subdivided mainly for topographical reasons into smaller divisions. The main divisions are, on the whole, just, since the whole rain-shadow area is characterised by a relative raininess in the month of May, which is lacking along the coast strip, but it seems probable that Mr. Reed has not made sufficient allowance for two facts regarding the coast strip. In Washington the month of maximum raininess is November, and the further south one goes the later in the season does this maximum occur, and at the same time the relative raininess shows considerable increase. Probably these facts would have commanded attention had Mr. Reed made rainfall graphs in a generalised form for his subdivisions instead of taking single places as types.

IN the *Philosophical Magazine* for January Mr. A. E. Young obtains formulæ for the effect of stiffness and stretching on the form of a suspended wire or tape. The importance of these investigations largely depends on their application to the steel tapes and other substitutes for the old chain in modern surveying.

IN a paper communicated to the Proceedings of the Cambridge Philosophical Society (xviii., 2), Dr. Norbert Wiener proves in a short note that the shortest curve dividing a given area in a given ratio consists of a circular arc or a number of such arcs, each terminated on the boundary of the area. The paper was originally intended to be a joint article by the author and Dr. Szász, and to contain a proof that the shortest curve dividing any scalene triangle in a given ratio is a circular arc with the most acute apex as centre. Owing to the war this has not been possible, but the results are so self-evident to an average English mathematician that no advantage would have been gained by a further discussion in print. The simplest plan is to replace the author's words, "dividing an area in a given ratio" by "cutting off a segment of given area from a given closed figure." The proof that the portion of the curve joining any two points on it is an arc of a circle is found in most text-books, and the reader should have no difficulty now in seeing, further, that the arc in question must meet the boundary at right angles (unless it passes through a re-entrant angle), whence the property which Dr. Szász intended to prove follows immediately.

THE December number of *Terrestrial Magnetism and Atmospheric Electricity* contains the results of the determinations of the deviation of the compass made on the magnetic survey ship *Carnegie* during her voyages from Brazil to St. Helena in 1913, and from

Norway to Iceland and thence to New York in 1914. The published charts of the South Atlantic all show the westerly deviation too small by a degree, or in one or two cases nearly two degrees, in the region 30° S., 24° W. Between Norway and Iceland the charts show deviations to the west 2° or 3° too small, between Greenland and Labrador they are 1·5° to 2° too high, and the British chart is nearly 3° too low at 55° N., 52° W. Along the east coast of America there are no serious errors in the charts as at present issued, although the U.S. chart is the least accurate of the three available.

Scientific Paper No. 231, issued by the Bureau of Standards, is devoted to a determination of the specific heat of copper over the temperature range 10° to 50° C., by Mr. D. R. Harper, of the bureau. The specimen of copper consisted of 50 metres of very pure annealed wire of 2·5 millimetres diameter wound into a compact coil 10 cm. diameter and 10 cm. long, with thin sheets of mica to maintain the insulation. The coil was suspended by silk threads in a vacuum vessel, and heated by an electric current sent through it. The current and potential difference at two points near the ends of the wire were determined by a potentiometer method. The standardisation of the wire as a resistance thermometer was carried out by the bridge method with the help of two standard platinum resistance thermometers. During the determination of specific heat the copper wire served as test specimen, as calorimeter, and as thermometer. The final result for the specific heat is $0{\cdot}0917+0{\cdot}000048(t-25)$ calories per gram degree.

A copy of a "Biographical Sketch of James Smithson" has been received from the Smithsonian Institution at Washington. It is an abridgment of a chapter on James Smithson by the late Dr. S. P. Langley in "The Smithsonian Institution, 1846–1896: the History of its first Half Century." The founder of the institution was born in 1765. He graduated at Pembroke College, Oxford, in 1786. At a time when the study of physical science was almost unknown in the University, he appears to have conceived already that devotion to scientific research which characterised all his future life. He was admitted as a fellow of the Royal Society in 1787, his recommendation being signed, among other men of science, by Cavendish, who became an intimate friend. Arago, too, was added to his friends later, and he was a correspondent of Black, Banks, and Thomson. Smithson died at Genoa in 1829. His will provided that in the event of the death of his beneficiaries, his property should pass to the United States of America "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." Thus his dearest wish that "my name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten" seems likely to be accomplished.

An electric tramway—described in *Engineering* for February 19—has been constructed recently to connect Osaka, which is the foremost industrial and commercial centre of Japan, with the town of Nara. The line is 19 miles long, and the steepest gradient is 1 in 30. The cars, which accommodate 100 passengers, and weigh 32 tons when fully loaded, are mounted on two trucks equipped with 160 horse-power motors. It was desired to keep the line as straight as possible, and the route selected for this reason involved the construction of four tunnels, the most important of which is the Ikoma tunnel. In cross-sectional area, this tunnel is the largest in Japan, and its length, which is 11,088 ft., is only exceeded by that of the Sasago tunnel on the Imperial Japanese Government Railways. The tunnel penetrates the Ikomayama Mountains, which rise to a height of 1500 ft. above sea-level. No shafts were used in the construction; work was commenced from both ends simultaneously in July, 1911, and the tunnel was completely finished in April last.

The publishers of the *Revue générale des Sciences pures et appliquées* (Librairie Armand Colin, 103 Boulevard Saint-Michel, Paris, 5e), have issued general indexes of the contents of the first twenty-five volumes (1890–1914) of our contemporary. There are two indexes; one is a subject index arranged under twenty headings according to the branch of science with which the articles are concerned, the other is an index arranged under authors' names. These excellent indexes will save readers much time and trouble when anxious to trace an article published several years ago. The price of the publication is 3·50 francs.

Messrs. G. Bell and Sons, Ltd., announce the publication at monthly intervals of sets of "Test Papers in Mathematics" for use in secondary schools. The series will be begun in May, and the first three sets to be issued will be compiled respectively by Mr. G. W. Palmer, Prof. T. P. Nunn, and Mr. H. C. Beaven.

OUR ASTRONOMICAL COLUMN.

Comet News.—A telegram from Prof. Strömgren, dated February 19, announces the discovery of an object by Miss Leavitt as Metcalf's periodical comet (1906 VI.). The discovery was made on February 9 at 12h. 33·7m. Harvard mean time, the position of the object being given as R.A. 8h. 30m. 37s., declination −1° 38′ 42″. No idea of the brightness of the comet is given, but as perihelion was passed last June the object may be considered very faint.

With regard to Mellish's comet, a further telegram gives details of an observation made at the Tashkent Observatory, Russia. On February 15, at 17h. 31·0m. Tashkent mean time, the comet's position was R.A. 17h. 9m. 11s., declination +2° 47′ 43″.

A numerous and interesting series of observations of Delavan's comet (1913*f*) is contained in the latest issue (November) of *L'Astronomie*. M. Quénisset contributes several photographs taken in August and September last illustrating the development of the tail. Of special interest perhaps are the observations of M. H. Law, of Hörsholm, Denmark. This observer made a number of estimations of the brightness of the comet, and found a distinct fluctuation in magnitude in a period of about three weeks. The magnitude of this change is illustrated in a table and diagram which he publishes in his communication. He shows further that this fluctuation in brightness was closely associated with the direction of the comet's tail in relation to the sun.

Magnitude Error in Parallax Determinations.—In the January number of the *Astrophysical Journal* Prof. Kapteyn describes a very ingenious device for avoiding systematic error depending on magnitude in the measurement of stellar photographs. If this error could be removed, Prof. Kapteyn does not see why it should not be possible—in the average of a sufficient number of observations or of a sufficient number of stars—to be able to reach almost any desired accuracy. The method of removing the error looks surprisingly simple, and seems to contain a complete solution of the problem. The idea is to obtain stellar photographs on which the stars of all different degrees of brightness are represented by perfectly equal images. To secure this two photographs of the same star region are required. The first photograph is taken when the plate is placed slightly within the principal focal plane of the telescope. On this plate it will be found that after development all the stars will be represented by circles of the same diameter but of different densities depending on the brightness of the stars. This negative is now replaced in the telescope exactly in its former position, the cones of light of the several stars falling on it as before. A second photograph—the main plate—is now taken *in focus*. It will be seen that the light of a bright or faint star before it can reach the main plate will have to pass through a dense or faint film screen respectively. In this way the images are brought nearer to equality. At present only one test has been made, and that not under the best conditions, but the results are certainly very promising.

Radiometric Measurements of 110 Stars.—A comparison of stellar radiometers and radiometric measurements on 110 stars is the title of a paper by Mr. W. W. Coblentz, which appears in the Journal of the Washington Academy of Sciences for January 19 (vol. v., No. 2). This paper, as stated, is only a brief summary of one to appear in the Bulletin of the Bureau of Standards. Reference is first made to experiments which show that there is little difference in the radiation sensitivity of stellar thermo-couples constructed of bismuth-platinum and thermo-couples of bismuth-bismuth plus tin alloy, which have a 50 per cent. higher thermo-electric power. A stellar thermocouple was found more sensitive than a bolometer, and greater improvements are expected in the former than in the latter. Measurements were made of the bright and dark bands of Jupiter, the rings of Saturn, a planetary nebula, and 105 stars. Quantitative measures were made on stars down to 5·3 magnitude, and high-grade qualitative measures on stars down to 6·7 magnitude. Red stars were found to emit from two to three times as much total radiation as blue stars of the same photometric magnitude. Measurements were also made of the transmission of the radiations from stars and planets through an absorption cell of water. Of the total radiation emitted blue stars had about twice as much radiation as yellow stars, and about three times that of red stars in the visible region of the spectrum. The object of the investigation was primarily to form some estimate of the sensitivity required to be able to observe the spectral energy curves of stars, and the author was led to conclude that by using a 7-ft. mirror and increasing the sensitivity of his present radiometer twenty times the required sensitivity could not only be reached but was possible.

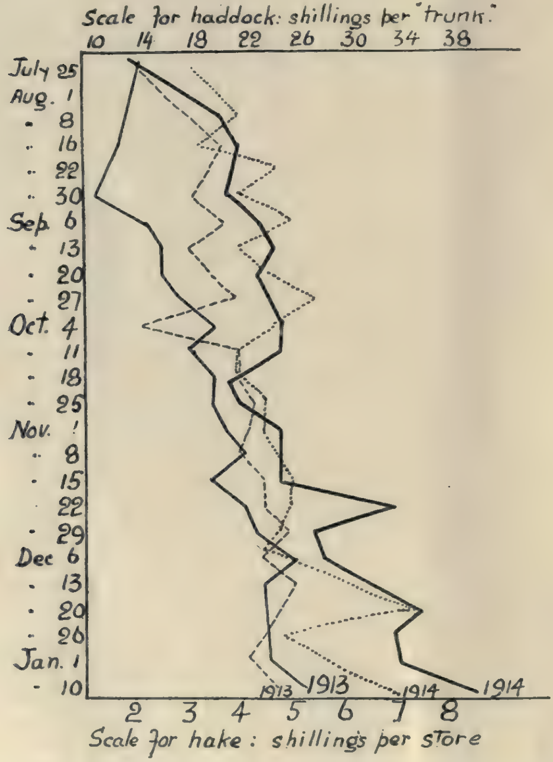
Determination of Time.—Under the title "Determinación de la Hora por Alturas absolutas, correspondientes é iguales de distintas Estrellas," Sr. Carlos Puente, of the Astronomical Observatory of Madrid, has published a very full account of the best-known methods of determining time by means of altitude observations of the sun and stars. The work consists of four chapters, of which the first deals briefly with the general principles of astronomical time, with its continuous record and methods of transmission. The other chapters discuss in detail the theory and practice of time determination, first by the observation of absolute altitudes based largely on a method developed by Prof. Donner, of Helsingfors, next by equal altitudes of the same object on both sides of the meridian, and thirdly by the observation of two stars at the same altitude. Each method is illustrated by practical examples, and the accuracy of the results is estimated. At the end of the work a number of useful numerical tables are given.

THE SEA FISHERIES AND THE WAR.

AFTER some six months of the war we can attempt to make estimates of its effects upon British industries, and anticipations of the future, with some degree of confidence. This is fairly easy with respect to the fisheries: the industry is being closely studied, and, unlike most, it is the object of both scientific and statistical investigation. The situation at present is one of extraordinary interest, even from a strictly scientific point of view. The enormous restrictions on fishery constitute (unhappily) an experiment on the grand scale, and since the scientific study of the industry has not altogether been allowed to drop interesting results should be forthcoming. The statistics of the next year or two will be of much value, in showing to what extent commercial exploitation of the North Sea depletes the natural resources of that fishing area. Amidst the distractions of the present time this question is not being neglected.

The industry itself has naturally suffered to a great extent. At the beginning of the war it was almost completely disorganised. About the beginning of August practically the entire Grimsby trawling fleet was laid up, and deep-sea fishing had almost been suspended; but at the beginning of October 500 Grimsby vessels had resumed fishing. Exports of both fresh and cured fish fell off to a great extent because of the loss of German trade. That country took more than 90 per cent. of the fresh fish exported from Britain, and about 43 per cent. of the pickled herrings. Russia took about the same proportion of our cured fish. This trade ceased, and at the beginning of August the stock of cured herrings held in Britain was estimated at 300,000 barrels, or about 37,500 tons in weight. How this part of the fishing industry has been affected since then it is still impossible to say. The quantities of fish landed also underwent a great decrease; in September, for instance, this decrease was about 38 per cent. of the quantity landed in the corresponding month of 1913. This falling-off has been due to several causes. A considerable number of trawlers were commissioned as mine-sweepers and patrol vessels—how many it is impossible to say. On August 18 the Navy List contained the names of 107 vessels, and two months later at least 200 of the total Grimsby fleet of 600 ships had been commissioned, or were waiting to be so. In itself this withdrawal of the best vessels, for defence purposes, led to a marked diminution of fishing; and since a large number of the best men were also taken there was a great shortage of officers, so that many other vessels were laid up. Restrictions, by the Admiralty, on the movements of trawlers, also affected the industry, though as time went on it became evident that some of these restrictions were unnecessary. The positions of the mine fields became known, since it was seen that these had been placed (with characteristic ingenuity) near places from which merchant vessels making for English and Scottish ports took final bearings. The mine danger did not, it appears, frighten the skippers of trawlers very greatly, and the Admiralty even threatened "disciplinary measures" on skippers neglecting their instructions and taking their ships into danger. In fact, the danger of mines was less than had been anticipated. At the end of September eight British steam fishing vessels had been destroyed by mines and twenty-four had been sunk or captured by the Germans. At the end of the year seven mine-sweepers had been lost with fifty-nine casualties, forty men being reported as killed or missing.

Fish became scarcer and dearer, though less so than had been anticipated. The chart below shows the mean wholesale prices[1] of two species of fish (haddock and hake) at Billingsgate Market during each week of the last five months of 1913 and 1914:—



The continuous thin line refers to haddock, and to the year 1913. The continuous thick line refers to the same fish sold in 1914. The broken line refers to hake of 1913; the dotted line to hake of 1914.

Haddocks are essentially North Sea fishes, the percentage taken from that area being about 61 per cent. Hake are southern fishes, and are taken mostly to the south-west of Ireland and towards the Bay of Biscay. There are always violent fluctuations in prices of fish due to the effect of gales on the supply, but apart from these the price rises towards the end of the year. The rise of price over that of 1913 is fairly considerable in the case of the North Sea fish, and much less so in the case of the southern species. But it is far less than anyone might have anticipated at the beginning of August. There was, in fact, a general tendency to keep prices as nearly normal as possible, and it was also seen that the public were certainly not prepared to pay highly exaggerated prices for fish.

The shortage of skippers and mates of fishing vessels is far from creditable to the country. It was pointed out in NATURE some time ago that there was great need for the education and technical training of deep-sea fishermen, and that facilities did not exist. The trawler section of the Royal Naval Reserve was established in 1911, and it was evident two or three years ago that both the Board of Trade and the Board of Education were alive to the necessity for the better technical instruction of deep-sea fishermen. The local machinery was, however, wanting, and the efforts that have been made since 1911 to provide this have been most unsatisfactory. Now the pinch has come. It is no secret that a much larger number of trawlers would be employed in defence operations if officers were obtainable.

The scientific investigation of the sea-fisheries has not been abandoned, but its most important side, the work at sea, has practically been discontinued. This has been unavoidable, and if the organisations in existence before the war can only be kept going a great recrudescence of activity may be expected when peace comes. It must be admitted that the probable defection of Germany from the international investigations will be a great loss. That country has made few original and fertile discoveries in fishery science[2]—it is to Norway that we are principally indebted. But Germany has characteristically carried on routine research in a very thorough manner, and we may miss this in the near future. May we hope that a result of the war will be the determination of Britain to make this research with the honesty and efficiency represented by the German publications We are only now realising how very painstaking was the German scientific and industrial campaign in the interest of her developing sea fisheries. It was stated a few weeks ago in NATURE that meteorological science had been pressed into the service of warfare by Germany. That has, probably, also been the case with some of the purely scientific results obtained during the investigation of the deep-sea fisheries; and it is a manifestation of *kultur* that we might very well imitate in the future, in peaceful interests.

J. J.

METEOROLOGICAL CHARTS FOR THE MEDITERRANEAN.

PROF. L. MARINI has contributed to the *Annali Idrografici* of the Hydrographic Institute at Genoa a brief descriptive account of the distribution of pressure and wind in the Mediterranean region, together with tables of averages and charts based upon them. The publication is intended primarily for the use of the seafaring man.

The tables of pressure contain normal values for the four seasons and the year for 174 places. The values are given in millimetres, but it is not stated in the tables or on the charts if the gravity correction has been applied nor to what period the values refer. The values are given to two places of decimals which implies a far greater degree of accuracy than would be possible with the instruments used at most of the places; to say nothing of the differences arising from the exposure of the instruments, the reduction to sea-level, and the hours of observation. The hours are not given, nor the heights of the places above sea-level, nor the months included in the seasonal periods. All these things may be of no interest to the sailor who will be expected to test the charts by his experience, but they are vital to the utilisation of the author's work by other meteorologists either for research or for incorporation in charts for wider areas.

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[1] The figures are summarised from the weekly lists published by the *Fish Trades Gazette*.

[2] Perhaps Hensen's quantitative Plankton methods are the exception to this statement.

The tables of wind give (1) for sixty-six places the "mean direction" of the wind for each season and the year, computed probably from Lambert's or some similar formula; (2) for seventeen regions of the Mediterranean the frequency of light, moderate, and strong winds for sixteen points of the compass, and the number of calms, also for each season and the year. The regions are roughly about 200 miles square.

The charts have been drawn with a great deal of care and the delineation is clear and attractive. They are on a relatively large scale, and consequently are folded into the book, which makes it troublesome to consult them, but the reader will feel that his trouble is compensated by the ease of seeing rapidly the general features and the details of the meteorological distribution. It may be remarked, however, that charts of normal distribution intended for the seafaring man ought to be printed on good linen-backed paper if they are to be used and not folded and put away in a drawer until a new set is received. Indeed, it is doubtful if the ordinary navigating officer will consult meteorological charts regularly until they are made part and parcel of his everyday equipment by being printed on his navigating charts.

Prof. Marini's charts showing the wind roses for the seventeen regions referred to, are very interesting, bringing out most clearly the relatively stormy winter conditions of the western Mediterranean and the great preponderance of winds from nearly due east or due west between Sardinia and Gibraltar. No wind rose is given for any part of the Adriatic.

E. G.

LORD KELVIN'S WORK ON GYROSTATICS.[1]

I.—*Gyrostatic Experiments in the Glasgow Classroom.*

WHEN I was a student, and afterwards when I was an assistant at Glasgow, Lord Kelvin lectured to his ordinary class twice a week, when he was not called away, and his subject was dynamics. About the middle of the session gyrostats made their appearance on the lecture-table, and we had wonderful gyrostatic experiments which filled us with delight, and gyrostatic questions in the weekly class-examinations which were equally productive of dismay. These gyrostatic questions, like many of our exercises in natural philosophy, were often of a numerical character. It is always a good thing to get down to numbers, and it is a most healthful mental discipline to be forced to "get the units right." Our equipment for the solution of these problems was of the slightest, for Lord Kelvin was himself so keenly absorbed in observing the behaviour of the apparatus, that he rather frequently forgot to give us the full dynamical explanation of the curious evolutions which we beheld. I could follow the process of composition of angular momenta, and could see that the axis of resultant angular momentum turned at that rate; but why should that also be the rate of turning of the axis of figure? That was my special difficulty, and it was only afterwards, when I got the idea of steady motion, and saw how the general equation is obtained and how it breaks down into the conditions for steady motion, that the matter became clear. Then I found, moreover, that in the general case there are two possible rates of turning. It is a good thing to stimulate the curiosity of a student to make him find out things for himself: it is also an excellent thing to anticipate his difficulties to some extent, lest he grow weary and faint by the toilsome dynamical way.

The lectures that we had were undoubtedly most interesting and suggestive, though they were not perhaps always directed to the more prosaic topics which formed the staple matter of the degree examination questions for ordinary students. The first experiment made was always that of the equilibrium of this nearly egg-shaped piece of wood, which, scientifically described, is a homogeneous prolate ellipsoid of revolution. Its surface may be imagined to be generated by the revolution of an ellipse about its longer axis. (The diagram, Fig. 1, shows a really egg-shaped solid.) I lay it on its side, and we see that in that position it is stable for fore and aft inclinations, "pitching" I may call the motion, and in indifferent equilibrium for port or starboard displacement, or rolling. This is, of course, all without spin.

If, however, I apply to the solid, as it lies on the tray before me, an impulsive couple with my fingers, so as to make it rotate about one of the minimum diameters (that is, of course, a diameter about which the moment of inertia is a maximum), the solid shows that when spin is applied the equilibrium is unstable.

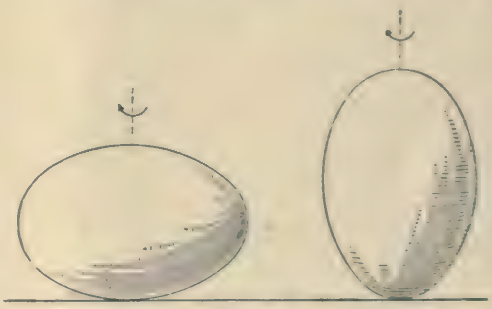

Fig. 1.

The ellipsoid at once sets itself on one end, and then rotates in stable equilibrium with the long axis nearly vertical. This is a very remarkable result. The centre of gravity has been raised, and the equilibrium is now stable. The spin has altered the conditions of equilibrium completely.

Of course, it was pointed out to us that all these phenomena are well shown by the ordinary spinning-top, spun by the unwinding from it of a string when the top has been skilfully thrown from the hand. Schoolboys are not encouraged now (indeed they are *dis*couraged by prefects and other important personages) to play with tops and marbles, and thus many phenomena of spin and collision which some of us used to observe are missed. The swaying round of the axis of a top when rising just after spin to the "sleeping" position, and the similar conical motion of the axis when the top is about to fall, give examples of precessional motion, of, in fact, the astronomical phenomenon called precession of the equinoxes.

Precession was illustrated by the interesting old model of a terrestrial globe which I have here (Fig. 2). You see that the globe is weighted so that a pin projecting from the north pole rolls round a ring, that is, a narrow cone fixed in the earth rolls in the inside of a cone fixed in space. These cones have their vertices at the earth's centre, the axis of the fixed cone is perpendicular to the ecliptic and its semi-angle is 23° 27′, that is, an angle equal to the obliquity of the ecliptic. On this ring, which represents the ecliptic, you have the intersections with it of the earth's equator—that is, the equinoxes—and so, as the earth turns, the two intersections move along the ecliptic, the equinoxes precess. The earth, in fact, is a top on which we happen to live, the spin is one turn in 24 sidereal hours, and the conical motion is completed in a period of 26,000 years (Fig. 3). One of our problems was to calculate the diameter of this pin for the earth, or, as it was sometimes put, to find the diameter of the north or south pole! If I remember aright the diameter is about 21 inches.

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[1] Abridged from the Sixth Kelvin Lecture, delivered at the Institution of Electrical Engineers, on January 28, by Prof. A. Gray, F.R.S.

These were our first gyrostatic experiments and illustrations. I must not omit to mention that the spinning of the ellipsoid was attempted also with each of two eggs, and that with one the experiment always succeeded, and with the other always failed. The reason of this failure and success was interesting; and although some students laughed at the experiment, it nevertheless arrested the attention of all. The contents of one egg were a viscid liquid, the contents of the other had been subjected to a process of coagulation by prolonged exposure to an elevated temperature. In other words, one egg, the one that would not spin on end, was raw, the other had been boiled hard. I now repeat this experiment, which is the scientific solution of the famous problem of Christopher Columbus, to make an egg stand on end.

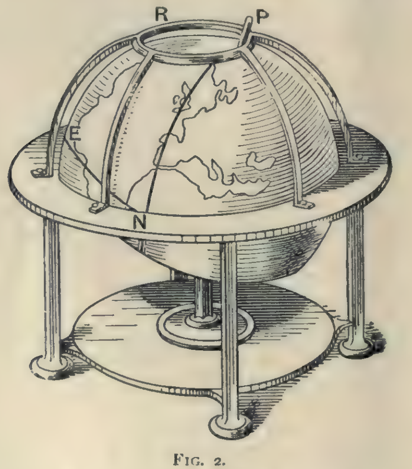

Fig. 2.

It is very easy to show, on principles which I hope to explain later, why the solid prolate ellipsoid, the piece of wood, or the hard-boiled egg, sets itself on end when it is spun about one of the shortest diameters; it is not at all easy to show why the raw egg does not.

I shall now say something of Lord Kelvin's papers and work on gyrostatics, taking the various topics more or less in chronological order.

II.—*Dynamical Theory of Rotation of Plane of Polarised Light.*

The first paper in which Lord Kelvin dealt with what may be regarded as a gyrostatic problem is that published by him in the Proceedings of the Royal Society,[2] entitled "Dynamical Illustrations of the Magnetic and the Heliçoidal Rotatory Effects of Transparent Bodies in Polarised Light." He does not in that paper use the term "gyrostat" or "gyroscope," but the equations which are arrived at in the discussion of the dynamical illustrations referred to are in form essentially of the kind which he afterwards called gyrostatic.

The fundamental idea of this paper is one which he developed a good deal in later papers and, from time to time, in his lectures to his students. It is that the rotation of the plane of polarised light transmitted through a solution of sugar or tartaric acid, or across a plate of quartz cut at right angles to the axis of the crystal, is to be explained by a helical structure of the medium; while what appears at first sight to be the exactly similar rotation of that plane, by passage of the light through a piece of heavy glass along the lines of force of a magnetic field, is due to rotational motion already existing in the medium and compounded with the motion produced by the wave of light.

Think (as I heard him once say) of a transparent elastic medium full of little helical hollows of the order of 1/40,000 in. in dimensions, having all their axes turned the same way, so that to an observer looking along them the helices are all right-handed or all left-handed, or at least are preponderatingly in one direction or the other. Such a medium would have the property of transmitting, in the direction of the axes of the helices, waves of torsional displacement at different speeds according as the torsion is right-handed or left-handed.

On the other hand, let us think of a transparent elastic medium in which are embedded in a homogeneous manner innumerable particles describing circular orbits, all of which, or a majority of which, face the same way, and are traversed by the particles in the same direction round. Now let a wave of turning motion of the medium be propagated in one direction or the other, parallel to the axes of the circles. A wave-motion of a certain rapidity in one direction round, say that of the motion of the particles in the circular orbits, will call for the same centreward force, applied to the particles by the medium, as a motion of greater rapidity applied in the contrary direction round. Thus oppositely directed circular motions will, for the same displacements of the medium, have different rapidities of turning (in planes perpendicular to the direction of propagation of the wave); the corresponding waves will travel at different rates, and one will gain on the other.

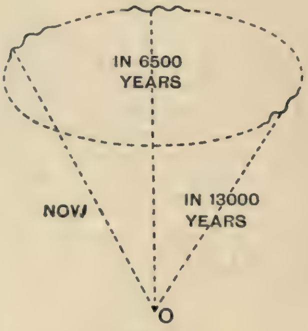

Fig. 3.

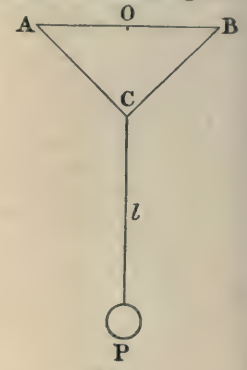

Fig. 4.

The illustration proposed was a double pendulum. A cord (see Fig. 4) is attached at the two ends of a horizontal rod A B, and to the middle point of this cord is fastened a simple pendulum, of length l as indicated. The distance of the bob from the rod is l', that is $l+OC$. The rod is made to turn with uniform angular speed ω about a vertical axis through its middle point O. The cords are supposed to be of negligible mass and quite flexible, and the bob is a massive particle.

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[2] Proceedings of the Royal Society, vol. viii, p. 150, 1856.

If ω were zero we should have a pendulum the period of which is $2\pi\sqrt{l/g}$ for vibrations in the plane of the paper supposed vertical, and $2\pi\sqrt{l'/g}$ for vibrations at right angles to that plane; and the motion of the bob in the most general form would be compounded of two such oscillatory motions.

When the motion, with ω not zero, is referred to two rectangular horizontal axes of x and y through O, which revolve with the rod, the equations of motion of the bob are

$$\ddot{x}-2\omega\dot{y}+\left(\frac{g}{l}-\omega^2\right)x=0,$$

$$\ddot{y}+2\omega\dot{x}+\left(\frac{g}{l'}-\omega^2\right)y=0,$$

where x, y are the co-ordinates of the bob and $\dot{x}$, $\dot{y}$ their time rates of change, and $\ddot{x}$, $\ddot{y}$ are the accelerations corresponding.

The second terms on the left-hand sides of these equations, $-2\omega\dot{x}$, $2\omega y$, are in form what were called afterwards by Lord Kelvin gyrostatic terms, and the conditions for the existence of real periods of oscillatory motion in the general case, depending, as the reality of these periods does, on the value of ω, gives us an idea of what he termed in that connection "gyrostatic domination."

In an Appendix to this lecture (see *Journal*, I.E.E.) will be found a synopsis of the solution of this interesting case of motion with some modifications of notation and mode of presentment. The reader may refer also to the original paper.[3]. It is reprinted as Appendix F of Lord Kelvin's "Baltimore Lectures."

The main results may be expressed as follows:—

(1) If a long straight rod, which is unequally elastic in two rectangular directions, or is of unequal diameters in these directions, if of uniform elastic quality (a rod of elliptic section, for example), be rotated rapidly about its axis, and vibrations be maintained in a fixed transverse direction at one end, waves of rectilinear vibration, the direction of which slowly turns round as the wave advances, will be propagated along the rod.

(2) Let the transverse elasticity of the medium (which, to fix the ideas, may be taken, as has already been suggested, as a long straight rod, along which waves of transverse displacement are propagated in the direction of its length) vary with the direction of the transverse, so that it has maximum and minimum values in axial planes at right angles to one another. If this rod be slightly and uniformly twisted about its axis, these planes become heliçoidal or screw surfaces. Think now of a line in space parallel to the axis of the rod. This line will intersect either of these surfaces at points the successive distances apart of which are all equal to the step s of the screw. If the rod be turned about its axis as a whole, each point of intersection will move along the line at a speed v which depends on the rate of turning.

Let a rectilinear vibration be kept applied at any cross-section, say one end, and let the rod be rotated about its axis in the proper direction, and at such a rate that the speed v just specified is equal to the velocity of propagation of the wave produced by the applied vibration. The result will be that a series of waves of rectilinear vibration will run along the rod, without any turning of the plane of vibration in space. In order that the rotation may be rapid, it is necessary that the wave-length, a say, should be many times the step s of the screw.

According to our notation the period of vibration is $2\pi/\mu$, and therefore the velocity of propagation of the waves is $a\mu/2\pi$. But if s be the step of the screw, and ω denote as before the angular speed of rotation, the value of v is $\omega s/2\pi$. Hence we must have $\omega s=a\mu$ or $\omega=a\mu/s$.

The effects of the twist and rotation thus exactly balance one another. The latter (see Appendix) gives a rotation of amount $\frac{1}{4}\pi\lambda^4/\omega^3\mu$ in a wave-length, or a complete turn in $8\mu\omega^3/\lambda^4$ wave-lengths. Hence the effect of a single turn of twist in a length s is equivalent to that of rotation in $8\mu\omega^3/\lambda^4$ wave-lengths.

The dynamical illustration is thus applicable to all the cases of turning of the plane of polarisation of light. There is one point of difference, however, which renders a rotational medium more truly representative of the magneto-optic turning, and is decisive as between a rotational and a structural explanation of the different phenomena. A beam of plane polarised light which has traversed a piece of heavy glass in a magnetic field will, if it be reflected and sent back through the medium, have the turning of the plane doubled by the backward passage, while backward passage through quartz or a sugar solution annuls the turning produced by the forward passage. These facts point, as Lord Kelvin repeatedly urged in his teaching, to a rotational explanation of the magneto-optic effect and to a structural explanation for the other.

III.—*Precessional Motion of a Liquid.*

About twenty years later gyrostatic problems attracted Lord Kelvin's attention in a very special way. From 1875 onward for several years he was much occupied with many things; for instance, he transacted much business connected with submarine cable instruments, eclipsing lights for lighthouses, and compasses and sounding machines. I was one of his assistants, and remember how busy we all were. For the two years from 1875 to 1877 there are set down in the list of his papers four on the subject of gyrostatic action, but of these only two were ever printed, the first and the last. The former was entitled "Vibrations and Waves in a Stretched Uniform Chain of Symmetrical Gyrostats,"[4] the latter "On the Precessional Motion of a Liquid."[5] I shall first give some account of the latter paper, because it contained descriptions and illustrations of gyrostats and gyrostatic action, and shall then return to the former.

The circumstances in which this paper was written were interesting. In 1875 Lord Kelvin (then Sir William Thomson) visited America as one of the judges of Group 25 (Scientific Instruments) of the Centennial Exhibition at Philadelphia. He then met and conferred on scientific questions with some of the most eminent natural philosophers of the United States.

A conversation with Simon Newcomb, in Joseph Henry's drawing-room in the Smithsonian Institution at Washington, led him to doubt the legitimacy of some of his own conclusions regarding the effect of elastic yielding of the crust on the precession and nutation of a liquid earth contained within a solid shell. These conclusions were stated in his paper on the rigidity of the earth,[6] and in §§ 847–8 of the first edition of Thomson and Tait's "Natural Philosophy." For example, he had decided that the yielding of the crust of an internally liquid earth, under the differential attractions of the sun and moon, would produce an effect on the precession so great as to be altogether incompatible with the excellent agreement between theory (on the hypothesis of a solid earth) and observation, as regards precession and nutation.

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[3] *Loc. cit.* above.

[4] Proceedings of the London Mathematical Society, vol. vi., p. 190. 1875; Math. and Phys. Papers, vol. iv., p. 535.

[5] British Association Report, 1876, Transactions of Sections, p. 1.

[6] Philosophical Transactions of the Royal Society, vol. cliii., p. 573, 1863.

Newcomb appears to have suggested that viscosity might possibly render precession and nutation the same as if the earth were rigid throughout. As a direct cause viscosity is inadmissible, but indirectly it is effective, for it at once occurred to Lord Kelvin that a very real cause of agreement between an internally liquid earth and a solid earth as regards precession at least, was probably to be found in the rigidity induced in the interior liquid by its rotation. Thus his attention was directed to the quasi-rigidity of a liquid induced by rotational (or vortex) motion, a subject which, as he told Section A of the British Association after his return from America, occupied his thoughts for weeks almost to the exclusion of all other scientific subjects.

He soon found that if the ellipticity is not too small the shell would not have more precession than the liquid, and that the compound rotating mass would have sensibly the same precessional motion as if it were a single rigid body. He came to the conclusion, however, that the lunar semi-annual and lunar fortnightly nutations would be greatly affected by interior liquidity of the earth.

At the Glasgow meeting of the British Association in 1876 Lord Kelvin was president of Section A, and began his presidential address by quoting the Anacreontic couplet:—

“ Θέλω λέγειν ’Ατρέιδας,
Θέλω δὲ Κάδμον ᾄδειν ”

which begins the complaint of the poet that no matter what hero he wished to sing, his lyre refused to respond to any theme but that of love. Try as Lord Kelvin liked to speak of the scientific men, and scientific inventions that he saw in America, of American education, or the more recent advances of physical science, his thoughts ever came back to the subject of the internal rigidity of the earth and the difficult questions therewith connected. So to this topic he decided to devote the major part of his address. This he did with great effect, clearing away what was doubtful from his former arguments, emphasising and enforcing them as they remained, and reiterating with undiminished confidence his old conclusions.

To illustrate the precession of a rotating liquid he showed later in Section A what he called a liquid gyrostat, and also for comparison various solid gyrostats which had for several years been used for the dynamical illustrations of the natural philosophy class. I have these very gyrostats here on the table, and will use them for a repetition of some of the old historical experiments of the Glasgow class-room.

IV.—*Solid and Liquid Gyrostats. Gyrostatic Experiments.*

The construction of a solid gyrostat is shown in the diagrams before you, which were made, partly by myself, nearly forty years ago (Fig. 5). The instrument consists of a massive flywheel surrounded by a case of brass. The wheel is a disc of thick brass carrying a massive rim, so that the moment of inertia is made as great as possible. One diagram of this slide, as you see, shows a section of the wheel and case, the other a side view of the wheel.

The case is a cylindrical box surrounding the flywheel, with extensions enclosing the axle, for which they are provided with bearings at the ends. Round the case, as nearly as may be in the central plane of the flywheel, is a projecting rim, the edge of which is not quite circular, but rather polygonal with curved sides, and the points of meeting of the sides rounded off. The rim serves to support the gyrostat, as it stands on this glass plate, in some of its evolutions.

The bearings are cups in which the rounded points of hardened steel of the axle run. This is not a good arrangement if the gyrostat is to be subjected to shocks, or to be roughly handled in any way. Oiling also is required, after every second spin at least. In our new gyrostats we use ball bearings designed to resist considerable shocks and stresses without derangement. With these, in some experiments, we have gone up to speeds of about 25,000 r.p.m., and have found the flywheel to be still rotating rapidly after the lapse of forty-five minutes. Also the wheel may be run for several hours with only one oiling.

It will be convenient to show here some of the experiments usually performed in the ordinary class of natural philosophy in Lord Kelvin's time. The multiplicity of subjects put down to be treated in the dynamical part of the course precluded, as I have hinted, any detailed explanations of these experiments. They were carried out, in fact, with the avowed and excellent purpose of exciting curiosity in the minds of the students, and a desire to find out why gyrostats behave in a manner at first sight so anomalous. Interest was certainly aroused in a few, but I fear that the majority despaired of penetrating such mysteries, and sought external help for the mastering of the more hackneyed topics of the degree examinations.

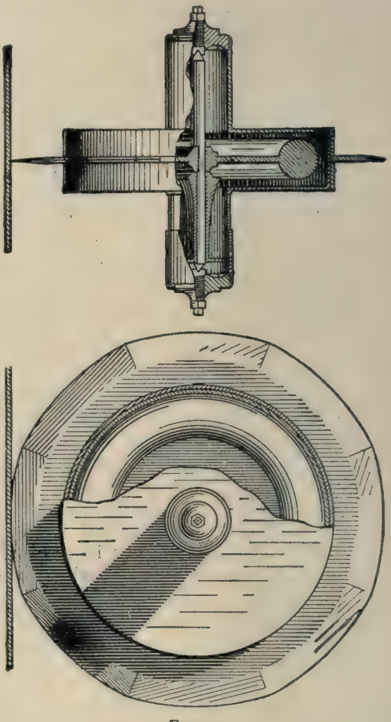

Fig. 5.

The process of spinning excited more interest than any other part of the experiment, for the ordinary elementary student cares more for a little bit of sensation than about the scientific result to be proved. A long cord was laid out on the floor, then the free end passed one and a half, or two and a half, times round the axle of the gyrostat, which was held by the operator, with its axis vertical, in a suitable socket on a table fixed to the floor. An attendant holding the free end ran away with it, slowly at first, then faster and faster, down a long passage and through a large adjoining room, while friction was applied to the cord as it entered the gyrostat case.

For the runner was substituted later a large wheel with grooved rim on which the cord was wound as it was drawn through the gyrostat. I estimate that speeds of about 100 turns per sec. or less may have been obtained in this way. Now, of course, one spins by an electric motor, as I shall presently describe.

I will make one or two of the experiments with the original gyrostats, but it will save time if I repeat the others with some of the new and improved gyrostats invented by Dr. J. G. Gray, whom I am fortunate in having to assist me on the present occasion.

[The usual experiments, illustrating precessional motion of a gyrostat with the axis horizontal, while under the influence of a couple due to the gyrostat overhanging, or to a weight hung on one end of the case surrounding the axle (Fig. 6) were performed.]

This behaviour of the gyrostat is often considered paradoxical, and must, I suppose, be regarded as difficult to explain in a popular manner. At any rate, the popular explanations are as a rule extremely unsatisfactory. Yet in this particular case of horizontality of the axis the matter is simple enough, I think. Let me illustrate by means of this pedestal top (Fig. 7). The curved arrowhead shows the direction of rotation, the projecting arrow the axis of spin, the arrow pointing down can be turned so as to show the direction of the axis of any applied couple. First observe that when I try to retard the precessional motion the axis descends, if I try to accelerate the precession the axis rises. This experiment shows that the horizontality of the axis depends on the freedom of the gyrostat to precess at a certain definite rate. This rate, as we shall see presently, depends on the couple applied by the weight of the gyrostat acting downward in one vertical line, and the pull of the string acting upward in another line nearly vertical, and on the angular momentum of the flywheel.

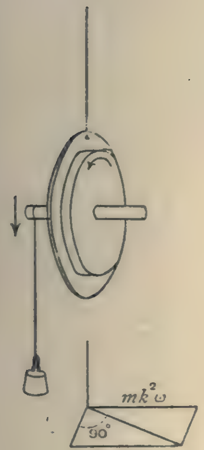

FIG. 6.

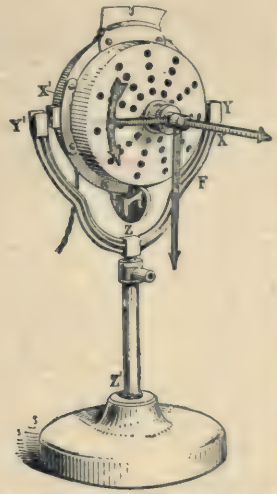

FIG. 7.—Motor-Gyrostat in "Fork and Pedestal" Mounting.

Look at the thing in this way. The axis of rotation round which the flywheel has angular momentum is turning as you see towards the horizontal axis A of the couple, with angular speed, Ω say. Now, and this is the point not recognised as a rule, this motion itself creates a rate of production of angular momentum about the axis A of the couple. For when an axis with which is associated a directed quantity, L say, is turning towards a fixed direction at right angles to it with angular speed Ω, there is a time-rate of production of the quantity associated with the latter direction measured by the product $L\Omega$.

Now the flywheel is revolving with angular speed ω, so that if its moment of inertia is mk^2, it has angular momentum $mk^2\omega$ about the axis R; but with angular speed Ω the axis R is turning towards the instantaneous position of the axis A, a fixed direction to which R is at the moment perpendicular, and, in consequence of this turning, a rate of production of angular momentum $mk^2\omega.\Omega$ exists about A.

Now for the steady motion of the gyrostat, that is, steady turning in azimuth without rising or falling of the axis, it is only necessary that this rate should be equal to the moment of the couple about A, G let us say. Thus we get $mk^2\omega\,\Omega = G$, which gives $\Omega = G/mk^2\omega$.

If I hurry the precession by giving a little impulse, and then leave the gyrostat to itself, the hurried motion, if it continued afterwards in the horizontal plane, would result in a more rapid generation of angular momentum about A than there is moment of couple to account for, and the gyrostat would begin to turn about A, in the direction to cause the angular momentum to be produced at the proper rate, that is the axis would begin to rise. In the same way an impulse towards delaying the precession would cause the axis to begin to descend. In each case the result would be a succession of alternate rises and descents; but the subject of vibrations about steady motion will be found treated in the Appendix, § (5) [see *Journal*, I.E.E.].

Here it is important to remark that there are two possible precessional motions for the same spin and the same inclination of the axis of spin to the vertical, which are given in the theory as the roots of a certain quadratic equation (see Appendix). One is great, the other small. The former to the first approximation does not depend on applied forces, the other does. Lord Kelvin called the former "adynamic," the other "precessional." But in strictness both involve the forces, and they appear as the roots of a certain equation. One of these is at once approximately realised when the wheel is spun fast, the gyrostat set on the plate at rest, and left to itself. The motion is one of small oscillation about the steady motion, which is characterised by slow precession, given very nearly, but not quite exactly, by the same formula as before. The other motion of the axis in the same cone is one of much greater precessional angular speed. The popular expositions which I have seen of gyrostatic steady motion as a rule ignore this second possible motion. It can be realised by proper means.

In strictness we must regard this second precessional motion as characteristic also of the gyrostat when its axis is horizontal, but in that case the precessional angular speed is infinite, and only the slow motion is realisable.

The rule, often stated, that hurrying a gyrostat in its precession causes tilting up of the axis, and delaying the precession causes tilting downward, is true only of the slower more usual precession. For the faster precession exactly the reverse rule holds good. This fact does not seem to be generally known, as the rule is generally stated absolutely.

It is important to notice that if the centre of gravity of the gyrostat is above the point of support, supposed on the line of the axis, the two precessional motions are in the same direction; if, on the other hand, the centre of gravity be below the point of support, the precessional motions are in opposite directions. The faster motion changes sign in passing through an infinite value, when the axis is horizontal.

By the effect of hurrying or retarding the precession was sometimes explained in our lectures the rising and falling of a top spinning on a rounded peg in contact with a rough floor along which the top can move. At first the spin is fast and the slipping is such as to produce a hurrying friction couple which causes the erection of the top. After the spin has fallen off the slipping is the other way and a couple which produces the reverse effect results, and the top falls.

[Experiments were here made with a gyrostat on gimbals, and with a gyrostat mounted on a trapeze hung by the crossed cords of a bifilar suspension. See "Gyrostats and Gyrostatic Action," NATURE, April 10, 1913, to illustrate the stabilising by spin of a gyrostat with two freedoms, both unstable without spin.]

As I have already stated, Lord Kelvin illustrated, by what he called a "liquid gyrostat," the fact that an oblate spheroidal shell filled with water behaves as regards precession as if its contents were solid. Here is the gyrostat with which the experiment was made (Fig. 8). It resembles the ordinary gyrostat, but the case is not completely enclosed, and the spheroidal globe containing water takes the place of the flywheel: these are the only points of difference. I spin the globe in the ordinary way, and you see that in all respects the liquid gyrostat imitates the behaviour of the solid one.

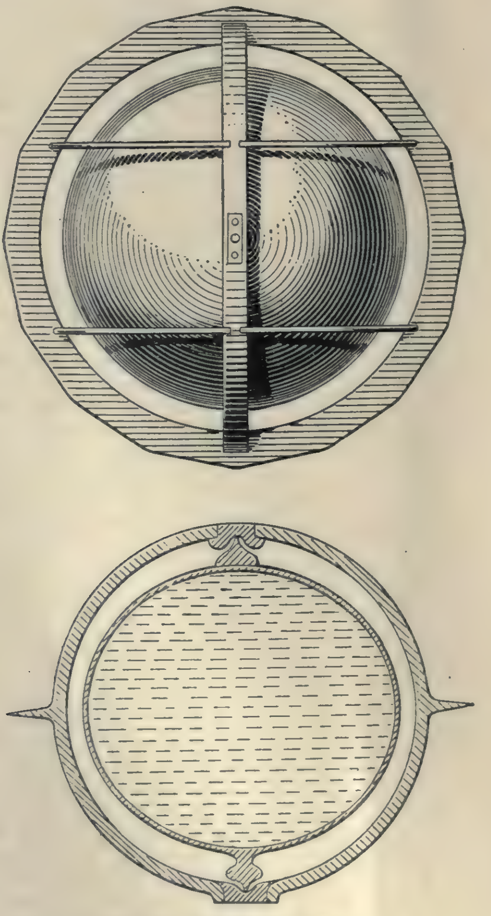

FIG. 8.—Liquid Gyrostat (Oblate).

This spheroid has an oblateness of about 5 per cent.; that is, the difference in length of the polar and equatorial diameters is about 5 per cent. of the length of either. Here, however, is another liquid gyrostat which has about 5 per cent. of prolateness (Fig. 9). I attempt to spin it, and you see that as soon as it is removed from the spinning apparatus its spin has entirely disappeared. In consequence of instability of the motion, the energy of rotation has been entirely transformed into heat, by turbulent motion of the water, into which the rotational motion breaks down. Permanent steady rotation of the liquid globe is impossible.

Oblateness, however, is not absolutely essential for steady rotational motion of a liquid round the axis of figure in a spheroidal case turning with the liquid. It was shown by Sir George Greenhill in 1880 (three years after the meeting of the British Association at Glasgow) that steady motion is possible in a prolate spheroid, if it be sufficiently prolate. The axial diameter, in fact, must either be shorter than the equatorial diameter, or be more than three times as long.[7] As Sir George Greenhill points out, a modern elongated projectile if filled with a liquid would not rotate steadily about its axis of figure, and therefore would not have a definite trajectory as a rifle bullet has; it would turn broadside on to the direction of motion.

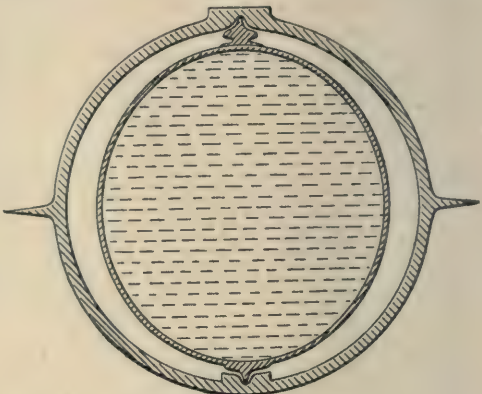

FIG. 9.—Liquid Gyrostat (Prolate).

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—The Society of Merchant Venturers, in whose Technical College the faculty of engineering is provided and maintained, has decided to offer ten scholarships, tenable in the faculty for three sessions, beginning with the session 1915–16, to the sons of officers in his Majesty's Service who have been killed in the war, and whose mothers or guardians are in needy circumstances.

CAMBRIDGE.—The adjudicators of the Smith's prizes and the Rayleigh prizes are of opinion that the following essays sent in by the candidates are of distinction:—H. Glauert, of Trinity College, on the elliptical form of a rotating fluid mass as disturbed by a satellite, and H. Jeffreys, of St. John's College, on (i) certain hypotheses as to the internal structure of the earth and moon, (ii) on a possible distribution of meteors, to whom the Smith's prizes have been awarded in alphabetical order. A Rayleigh prize has been awarded to J. Proudman, of Trinity College, for his papers on tidal motions.

MR. HERBERT A. L. Fisher, vice-chancellor of the University of Sheffield, has been elected a trustee of the British Museum, in succession to the Right Hon. Sir George O. Trevelyan, Bart., O.M., who has resigned on account of ill-health.

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[7] Proceedings of the Cambridge Philosophical Society, 1880 Encyclopædia Britannica," article, "Hydromechanics."

PROF. ARTHUR KEITH, conservator of the museum of the Royal College of Surgeons of England, will deliver, during the latter part of March, a course of five lectures upon the bearing of recent discoveries on our conception of the evolution and antiquity of man. The lectures will be given under the terms of the Macbride Foundation in Western Reserve University, Cleveland.

THE London County Council has arranged for a series of five public lectures to be given at the Horniman Museum, Forest Hill, on Wednesday evenings at 7.30 o'clock. The series commenced yesterday with a lecture on the Andamanese and other pigmies. The subjects of the remaining lectures will be: the Australian Aborigines; the Eskimo; the Papuans of New Guinea; and the Maori and other Polynesians. Each lecture is complete in itself, and there is no charge for admission.

A LECTURESHIP in ophthalmology has been established in Dublin by the bequest of Mr. R. J. Montgomery, who desired that it should be known as the Mary Louisa Prentice Montgomery lectureship, and that the appointment to it should rest each alternative five years with the Board of Trinity College, Dublin, and with the president, vice-president, and council of the Royal College of Surgeons in Ireland. Joint regulations for the lectureship have now been drawn up, and the first election will take place at the beginning of the next summer session.

THE distribution of prizes and certificates at the Sir John Cass Technical Institute and the opening of the new metallurgy laboratory for the mechanical testing of metals and alloys, presented to the institute by the Worshipful Company of Goldsmiths, by Sir Robert G. C. Mowbray, Bart., Prime Warden of the Worshipful Company of Goldsmiths, will be held on Wednesday, March 3, at 8 p.m. The chair will be taken by Sir Thomas H. Elliott, K.C.B., chairman of the governing body. There will be an exhibition of work by students of the department of arts and crafts and by members of the Arts and Crafts Society, as well as an exhibition of students' work and apparatus in the laboratories and workshops.

A NOTE in the *Daily Chronicle* of February 24 refers to the effect of the war upon the attendance of students in the twenty-two German universities. It appears that entered on their books are 52,504 students, against 59,600 this time last year. But of these 29,882 have been "permitted" to join the military forces of the Empire, including 300 women students in the army medical department. The actual attendance at lectures is given as 18,922 men and 3700 women. If the students of technical high schools with university status are added the grand total of 38,400 is reached, or about 75 per cent. of the entire number. The universities most depleted of students are those nearest the frontiers—Bonn and Heidelberg in the west, and Königsberg and Breslau in the east. It is stated in *Science* of February 12 that there are matriculated in the University of Berlin 7037 men and 898 women, as compared with 8200 men and 859 women last winter. These numbers show a marked contrast with those of our own universities; for at Oxford and Cambridge alone the number of undergraduates now in residence is about 2300, whereas at the like period last year it was 6700.

THE Council of the London (Royal Free Hospital) School of Medicine for Women is now arranging for a considerable extension of laboratory and teaching accommodation. This extension is necessitated both by the increasing number of women desirous of entering the medical profession and by the recognition of the fact that research work must be regarded as an integral part of education, and that no medical school can be considered as satisfactorily equipped without full facilities for the carrying out of scientific investigations. A site adjoining the present buildings of the school has been secured, and the extension will include additional accommodation for teaching and much improved facilities for research work. For this very necessary extension the sum of 25,000*l.* is necessary for building and equipment, and a further similar sum for endowment. By the kindness of the Duchess of Marlborough a meeting was held at Sunderland House on February 18 to promote the extension. The speakers were the Duchess of Marlborough (in the chair), Surgeon-General Sir Alfred Keogh, Dr. Mary Scharlieb, Dr. Florence Willey, Dr. Winifred Cullis, and Mr. Acland, M.P. The Duchess of Marlborough in her speech brought out the extreme urgency of the careful use of medical service during this present crisis and the great necessity for an increased service in the future, and particularly of medical women, who were needed as medical inspectors of school children and as workers in maternity and infant welfare centres, whilst there was also a very great need amongst women for practitioners of their own sex. Sir Alfred Keogh, Director-General of the Army Medical Service, paid an eloquent tribute to the work of the school, with which he had familiarised himself when, a few years ago, he had for the Board of Education to inspect practically every medical school in the country, saying that he yielded to none in his admiration of the school. He further made the gratifying announcement that as a result of the excellent work done by medical women in the war he had offered to two medical women who had organised a hospital unit in Paris, and later one at Boulogne, a hospital of 500 beds, or, if they could staff it, of 1000 beds here in England. The other speakers emphasised the necessity there would be for medical women after the war, when prophylactic measures would be of greater importance than before, and such work as ante-natal treatment and infant care would be of even greater significance when every child would be of added value.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 18.—Sir William Crookes, president, in the chair.—Prof. W. A. **Bone** and others: Gaseous combustion at high pressures. Mixtures of methane with less than its own volume of oxygen were exploded in steel bombs at initial pressures of between 8 and 32 atmospheres. The results were in harmony with the "hydroxylation" theory of hydrocarbon combustion put forward some years ago by Prof. Bone. Results of experiments upon an equimolecular mixture of ethane and oxygen have again confirmed the hydroxylation theory. Another section of the paper deals with an experimental determination of the relative affinities of methane, hydrogen and carbon monoxide for oxygen in flames. It is shown (1) that the affinity of methane is at least twenty times as great as that of hydrogen; (2) that when mixtures corresponding to $CH_4+O_2+xH_2$ are fired under high initial pressures, in which the partial pressures of methane and oxygen are kept constant and x only varied, the distribution of oxygen between the methane and hydrogen varies with x^2—which means that hydrogen is burnt *directly* to steam in flames as the result of the tri-molecular change $2H_2+O=2H_2O$, and not (as some have supposed) *indirectly* through hydrogen peroxide. The affinity of carbon monoxide is shown to be comparable with that of hydrogen for oxygen in flames. The final section describes experiments in which the whole pressure curves, up to and far beyond the attainment of maximum pressure, were recorded when mixtures corresponding to (1) $2H_2+O_2+4N_2$, (2) $2CO+O_2+4N_2$, and (3) $CH_4+O_2+4N_2$ are exploded under initial pressure of about 50 atmospheres. The rates of attainment of maximum pressure in each case have no direct relation to the order of affinities of the various gases for oxygen.—Prof. W. M. **Hicks**: The orbits of a charged particle round an electric and magnetic nucleus. Two problems are discussed—the orbits of α-particles and the orbits of electrons round nuclei containing mass, a definite number, n, of positive electronic charges and a definite number, N, of co-axial magnetons—the motion being in their equatorial planes. It is found that combined systems (atoms) with α-particles may exist in which the α-particle revolves in permanent connection with the nucleus, provided the internal energy of the atom is greater than a certain critical value, and that states of "radio-active" instability occur in which, after a combination of long duration, the α-particle is shot off to infinity. The exact velocity of emission in any case depends on the values of the n, N, but it is of the order of magnitude of the velocity of emission of α-rays from radium. In the case of electronic orbits, in addition to the combined systems with internal energy less than from infinity, there can exist also permanent systems in which the internal energy is greater than that from infinity, although less than a certain critical amount, and in which again states of "radio-active" instability occur of the proper order of magnitude.—S. **Chapman**: The lunar diurnal magnetic variation and its change with lunar distance. Balfour, Stewart, and Schuster have developed a theory of the solar diurnal magnetic variations which attributes them to electric currents in the upper atmosphere, impelled by electromotive forces produced by the motion of the air across the earth's permanent magnetic field. The atmospheric conductivity is supposed to be wholly or partly due to solar influence and varies with the sun's hour angle. This theory apparently applies also to the lunar diurnal magnetic variations which possess a semi-diurnal component of constant phase, together with other components the epochs of which depend on the angular distance between the moon and sun; hence, when averaged over a lunation, all components save the former disappear. The suggested solar influence on the atmospheric conductivity is thus supported, and a semi-diurnal atmospheric oscillation—such as a lunar atmospheric tide—is suggested as the source of the magnetic variations. Before this theory was developed, Brown (Trevandrum Observations, 1863) had found that the amplitude of the 12-hour magnetic component at perigee was to that at apogee in the ratio of (lunar distance)$^{-3}$ at the two epochs—"as in the tidal theory," he briefly remarked; but Figee (Batavian Observations, 1903) disputed this conclusion. The present paper discusses the evidence, of this direct kind, for or against a tidal origin of these magnetic variations. Brown's and Figee's data are used, together with much newly computed material from other observatories. The total hypothesis is confirmed, although on account of the accidental errors affecting the minute quantities under discussion, the exact law of (distance)$^{-n}$, with $n=3$, is not beyond question, but if n is assumed necessarily integral, its value is certainly 3 and not 2 or 4.—Lt.-Col. J. W. **Gifford**: Some temperature refraction coefficients of optical glass. This is a supplement to a paper read in 1912 in which the refractive indices for 13 wave-lengths of 27 different glass meltings were given by the author. To this table are now added similar indices for six more Jena glass meltings, including those for the recent fluor crown. This is followed by a table of the temperature refraction coefficients for all the glass meltings dealt with, and attention is directed to the abnormal coefficients for fluor crown which is a minus quantity. An attempt is then made to determine, if only approximately, the influence of barometric changes on the refractive powers of optical glass which would seem to be, similarly, a minus quantity, amounting to something like six units in the sixth decimal place only.

Royal Meteorological Society, February 17.—Capt. H. G. Lyons, president, in the chair.—A. E. M. **Geddes**: Observations of the upper atmosphere at Aberdeen by means of pilot balloons. These observations were made at the Observatory, King's College, Aberdeen, during the years 1912 and 1913; and in every case two theodolites were used, thus securing an accurate determination of the flights to a level of 3000 metres. In clear weather the upward velocity of the balloon is shown to be fairly uniform, but to depend on more than the free lift. When clouds are present they influence considerably this velocity, the effect differing according to the nature of the cloud. The gradient wind velocities and directions have been calculated and compared with those actually found by observation.—V. G. **Anderson**: Influence of weather conditions upon the amounts of nitric acid and of nitrous acid in the rainfall at Melbourne, Australia. The author described the methods adopted and stated that the results of the daily determinations from November 1, 1912, to February 28, 1914, when correlated with the meteorological data for Melbourne and the isobaric charts for Australia, reveal the existence of a relation between weather conditions and the amounts of the nitrogen acids in the rainfall. The concentration of nitric acid reached a maximum in summer, a minimum in winter, and an intermediate position in autumn and spring. The concentration of nitrous acid reached a maximum in winter and a minimum in summer. Nine well-defined recurring types of rainstorms have been investigated, the amounts (pounds per 1000 acres) of oxidised nitrogen per day varying from 1·5 in the case of certain antarctic storms to 35·0 in the case of intense tropical storms.

Institution of Mining and Metallurgy, February 18.—Dr. F. H. Hatch, president, in the chair.—J. **Morrow Campbell**: Notes on some gold occurrences in Ashanti. Some 30 miles to the west of Kumasi are to be found igneous rocks intruding through the schist, some of which are granite, and non-auriferous. The non-granite dykes, on the other hand, are mostly auriferous, and the author has devoted special attention to three of these in his paper. All three are comparatively old, and show abundant internal evidence of the continuance of the crustal movements to which they owe their existence. These movements have produced fracturing, and have resulted in the formation of quartz veins traversing the igneous rock in all directions, and varying in width from more than a foot to mere partings. After describing in detail the composition and characteristics of these dykes, the author draws certain deductions. He points out that in Ashanti pyrites is abundant in quartz veins, and elsewhere, quite unassociated with gold, but that where arsenopyrite occurs gold so frequently accompanies it as to lead to the conclusion that their association cannot be fortuitous. He thinks it fair to conclude that the arsenopyrite caused the precipitation of the gold, and that the solution transporting the gold contained the latter in combination with silica either as a silicate or as alkaline aurosilicate. The phenomena, he thinks, demand a single solution from which gold and silica may be precipitated simultaneously.—W. G. **Holford**: Some features in the mining problems of the eastern Witwatersrand area. This paper is a general review of the more intricate geological problems associated with mining in the particular area referred to, where conditions are somewhat different from those met with in the central Rand. For example, while it is found on the central Rand that the close proximity of the zones in which economic gold values are contained are in such close proximity as almost to constitute defined shoots, on the eastern rand the zones are less frequent and are of greater economic value in the synclinal portions of the areas. The author goes on to describe in detail the various features of mining practice in the district under consideration, dealing respectively with mining areas, shaft sinking, initial development, the mechanical equipment, and the labour problems encountered. Incidentally he makes a strong argument in favour of circular as against rectangular shafts.—W. B. **Middleton**: Prospecting tin land in Malaya. This is a practical paper concerning itself with the alluvial deposits which are the principal source of the tin production of the Malay Peninsula. The author gives full particulars of the various methods employed in treating, prospecting, and sampling the ground, including an elaborate description of the tools required, and as an appendix he furnishes a set of tables for calculations and conversions in connection with the work, which should prove of great utility.

CAMBRIDGE.

Philosophical Society, February 8.—Dr. Barnes, vice-president, in the chair.—Sir J. J. **Thomson**: Theory of the mobility of negative ions.—Dr. G. F. C. **Searle**: (1) The determination of the focal length of a thick mirror. (2) Experiment on the focal lines formed by refraction at a plane surface. (3) Calculation of the electrical resistance of a certain network of conductors.—C. T. R. **Wilson**: A method of measuring the thickness of thin plates. The method is a modification of that of Macé de Lépinay and Buisson in which μe, the product of refractive index and thickness, is obtained by measurements of the thin-plate fringes and $(\mu-1)e$ by observing the retardation produced by the plate when inserted in the path of a beam of light.—G. W. **White**: Investigation of the "wolf-note" in bowed stringed instruments. With all stringed instruments of the violin type a pitch can be found at which it is difficult and often impossible to obtain a pure steady tone. In the preliminary experiments to investigate this imperfect note photographs were obtained of the belly vibration of a 'cello by reflecting a beam of light from an optical lever to a moving photographic plate. A series of notes through the "wolf-note" played with a constant bow pressure was studied. At the "wolf-note" the vibration curve had an extremely big amplitude and showed that the unsteady nature of the tone was due to a "beating" of the instrument belly. The experiments proved conclusively that the "wolf-note" was caused by the impressed string pitch coinciding with the pitch of best resonance of the instrument.

MANCHESTER.

Literary and Philosophical Society, January 26.—Mr. F. Nicholson, president, in the chair. W. C. **Jenkins**: Manchester fogs of the last ten years. A comparison of the fogs in Manchester during 1904–1913 inclusive showed that the number of days affected by this phenomenon has increased during the latter years by at least 30 per cent. as compared with the earlier years of this period. By a rearrangement of the figures into seasonal effects the most striking feature is the increase of days classified as "gloomy" during the summer months, the number during the winter months of October to March remaining fairly constant. The number of days affected by "gloom" increased 100 per cent. during the period of the last four years as compared with the number so classified in the first four years of the period under consideration. These fog glooms are situated close to the earth's surface, as is shown by a comparison of sunshine records taken from the roof of the School of Technology and on the ground, the hours of sunshine measured on the ground being approximately 10 per cent. less than the amount recorded from the roof (100 feet higher).—Prof. W. W. Haldane **Gee**: Note on the monthly variation of sunshine. As a result of his examination of the Campbell-Stokes records, the author found that the average percentage of the possible sunshine usually reaches a maximum in May. A number of examples of this law were quoted. It was true for Glasgow, Douglas (I. of M.), Llandudno and Stonyhurst, 1880–1885; for St. Aubins (Jersey), 1880–1885; Blackpool, 1882–1885; Buxton, 1881–1885; Durham, 1880–1884; and for the Godlee Observatory (Manchester School of Technology), 1906–1910. The records for Stonyhurst for the thirty-three years from 1880–1912 also show the maximum in May. For 1910, Manchester (Oldham Road), Manchester (Whitworth Park), Buxton, Blackpool, and Llandudno also show the maximum in May. The author thought that the sunlight in May must have an important influence on vegetable growth.—W. C. **Jenkins**: Weather repetitions, with suggestions for long-distance forecast. Attention was directed to the repetitions in the weather for periods of twelve hours, twenty-four hours, seven days, and the lunar month, and also annual repetitions, making certain allowances—using particularly the records of rainfall. With the view of establishing these repetitions to a definite origin, the author showed the connection between numerous cyclonic paths and extra terrestrial phenomena, and assuming similar forces acting in temperate latitudes, he proceeded to demonstrate that cyclonic movements in the regions of this kingdom followed very much the variations expected under these conditions.

BOOKS RECEIVED.

Breeding of Farm Animals. By Prof. M. W. Harper. Pp. xvii+335. (New York: Orange Judd Co.; London: Kegan Paul and Co., Ltd.) 1.50 dollars.

Practical Physical Chemistry. By Prof. A. Findlay. Third edition. Pp. xvi+327. (London: Longmans and Co.) 4*s.* 6*d.* net.

A Summer on the Yenesei (1914). By M. D. Haviland. Pp. xi+328. (London: E. Arnold.) 10*s.* 6*d.* net.

Board of Education. Examinations in Science and Technology, 1914. Examination Papers and Reports of Examiners. Pp. 142. (London: H.M.S.O.; Wyman and Sons, Ltd.) 9*d.*

Alone in the Sleeping Sickness Country. By Dr. F. Oswald. Pp. xii+219. (London: Kegan Paul and Co., Ltd.) 8*s.* 6*d.* net.

Arabia Infelix, or, the Turks in Yamen. By G. W. Bury. Pp. x+213. (London: Macmillan and Co., Ltd.) 7*s.* 6*d.* net.

The Chemistry of Petroleum and its Substitutes. By Drs. C. K. Tinkler and F. Challenger. Pp. xvi+352. (London: Crosby Lockwood and Son.) 10*s.* 6*d.* net.

Journal Kept by David Douglas during his Travels in North America, 1823–1827, etc., with appendices containing a List of the Plants introduced by Douglas, and an account of his death in 1834. Pp. 364. (London: W. Wesley and Son.) 21*s.* net.

Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1913. Pp. 417. (Ottawa: J. de L. Tache.)

Icones of the Plants of Formosa, and Materials for a Flora of the Island. By B. Hayata. Vol. iv. Pp. vi+264+plates xxxv. (Taihoku: Government of Formosa.)

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology, vol. ii., No. 2, Oligochaeta. By H. A. Baylis. Pp. 13–18. Zoology, vol. ii., No. 3, Parasitic Worms, with a Note on a Free-living Nematode. By Dr. R. T. Leiper and Surgeon E. L. Atkinson. Pp. 19–60. (London: British Museum (Natural History); Longmans and Co.) 1*s.* and 1*s.* 6*d.* respectively.

The Chemistry of Colloids and some Technical Applications. By Dr. W. W. Taylor. Pp. viii+328. (London: E. Arnold.) 7*s.* 6*d.* net.

Forest Valuation. By Prof. H. H. Chapman. Pp. xvi+310. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s.* 6*d.* net.

X rays and Crystal Structure. By Prof. W. H. Bragg and W. L. Bragg. Pp. vii+228. (London: G. Bell and Sons, Ltd.) 7*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY, February 25.

Royal Society, at 4.30.—The Effect of the Depth of Pulmonary Ventilation on the Oxygen in the Venous Blood of Man: Prof. L. Hill and J. F. Twort.—The Effect of Functional Activity upon the Metabolism, Blood Flow and Exudation in Organs: J. Barcroft and Toyojiro Kato.—The Osmotic Balance of Skeletal Muscle: Miss D. Jordan Lloyd and W. B. Hardy.—The Function of Chlorophyll: Dr. A. J. Ewart.—Contributions to the Study of the Bionomics and Reproductive Processes of the Foraminifera: E. Heron-Allen.—The Influence of the Hydrogen Concentration upon the Optimum Temperature of a Ferment: A. Compton.

Royal Institution, at 3.—Struggle of Nations: Dr. P. Chalmers Mitchell.

Child Study Society, at 6.—*Discussion:* The Care and Development of the Child—from Ante-Natal Period to Five Years of Age. Ante-Natal Period: Dr. G. Eric Pritchard; Infancy: Miss J. Halford; One to Five Years: Dr. D. Forsyth.

Institution of Electrical Engineers, at 8.—Electricity applied to Mining: C. P. Sparks.

FRIDAY, February 26.

Royal Institution, at 9.—Solar Eclipse of 1914: The Rev. A. L. Cortie.

Physical Society, at 5.—Magnetic "Character" Figures, Antarctic and International: Dr. C. Chree.—The Electrification of Surfaces as Affected by Heat: Dr. P. E. Shaw.—Electromagnetic Inertia and Atomic Weight: Prof. J. W. Nicholson.

SATURDAY, February 27,

Royal Institution, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

Essex Field Club (at the Essex Museum, Stratford), at 6.—Incisor-teeth of Rhinoceros: E. T. Newton.—Palæolithic Implements and Plant Seeds from the River Gravel at Hackney Wick in the Lea Valley: A. Wrigley.—The New Witches-Broom on the Crack Willow: Miller Christy.—East Anglian Gravels: W. H. Dalton.

MONDAY, March 1.

Society of Chemical Industry, at 8.

Aristotelian Society, at 8.—The Æsthetic of Benedetto Croce: A. A. Cock.

Victoria Institute, at 4.30.—The Spectra of Stars and Nebulæ: Prof. A. Fowler.

Royal Society of Arts, at 8.—Motor Fuels: Prof. Vivian B. Lewes.

Society of Engineers, at 7.30.—Running Costs of Motor Vehicles: Lieut. R. W. A. Brewer.

TUESDAY, March 2.

Royal Institution, at 3.—Photographic Appreciation of Colour in Monochrome: Prof. W. J. Pope.

Royal Society of Arts, at 4.30.—The Northern Territory of Australia: Past, Present, and Future: D. Lindsay.

Röntgen Society, at 8.15.—The Chemistry of the Radio Elements: A. Fleck.

WEDNESDAY, March 3.

Society of Public Analysts, at 8.—The Soluble Chlorides and Total Chlorine in some English Cokes; S. W. Bridge.—The Routine Detection and Estimation of Boric Acid in Butter: H. Hawley.—The Structure of Pepper—Some New Features: T. E. Wallis.—The Occurrence of Chlorine in Coal: A. de Waele.

Institution of Electrical Engineers (Students' Section), at 7.45.—The Application of Electrical Engineering to Warfare—Communications, Wireless, etc.: P. R. Coursey; The Laying and Firing of Mines: S. G. Killingback; Searchlights and Projectors: E. L. M. Emtage.

Royal Society of Arts, at 4.30.—Shakespeare's Profession: W. Poel.

Entomological Society, at 8.

THURSDAY, March 4.

Royal Society, at 4.30.—*Probable Papers:* A Bolometric Method of Determining the Efficiency of Radiating Bodies: Prof. W. A. Bone, Prof. H. L. Callendar, and H. J. Yates.—The Simplification of the Arithmetical Processes of Involution and Evolution: E. Chappell.—The Elastic Properties of Steel at Moderately High Temperatures: F. E. Rowett.

Royal Institution, at 3.—Poetry and War: Sir Herbert Warren.

Royal Geographical Society, at 5.—Suess's Classification of the Eurasian Mountains: Prof. J. W. Gregory.

FRIDAY, March 5.

Royal Institution, at 9.—Mimicry and Butterflies: Prof. E. B. Poulton.

Geologists' Association, at 8.—Geology of the Glasgow District: Prof. J. W. Gregory.

SATURDAY, March 6.

Royal Institution, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

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